CIVIL ENGINEERING

PHOTOGRAMMETRY

A DRAMATICALLY EXPANDING TECHNIQUE FOR HIGHWAY ENGINEERS. SEE ARTICLES BY C. L. MILLER AND A. O. QUINN.

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...There is an Irving Grating Sales Engineer in the area to assist you.

Specially trained consultants, stationed throughout the country, draw upon over 50 years of grating experience to show you how grating can save you time and money and improve your job, whatever it may be . . . wherever it is.

✻ We manufacture all types of industrial gratings, in steel, aluminum and other metals

From the time we founded the grating industry, in 1902, we have made an almost endless variety of applications of grating to solve numerous and varied engineering problems.

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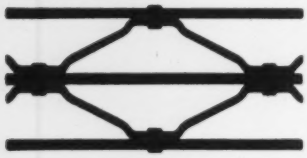

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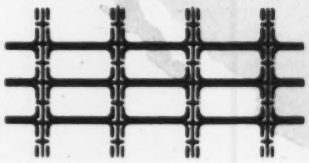

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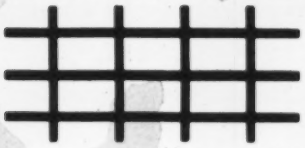

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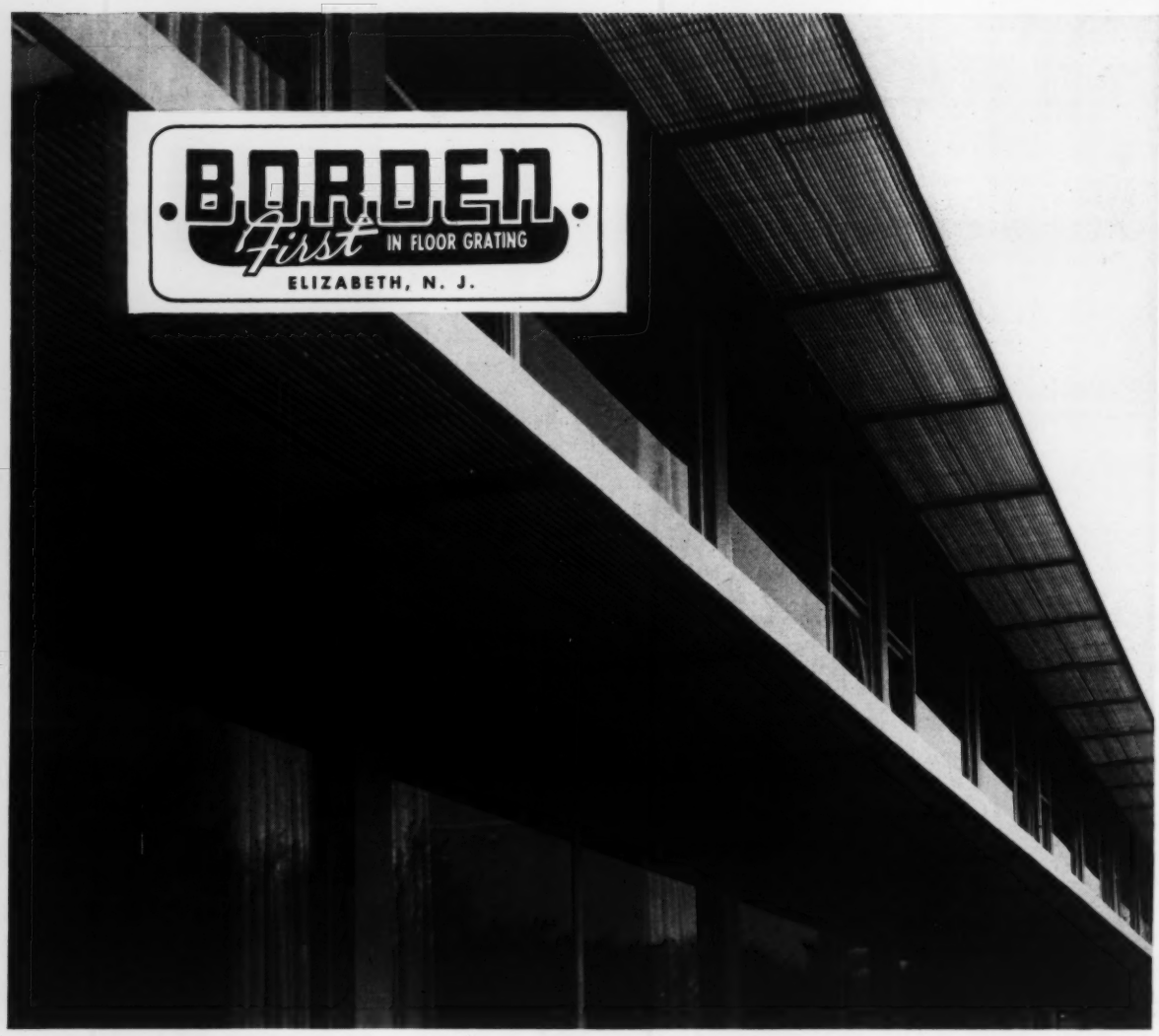
Working from barges, Brennan Brothers of La Crosse, Wisconsin and Lansing, Iowa placed spiralweld foundation pipe in 8 feet of water, then had to drive through 40 ft. of Mississippi River sand, clay and mud bottom. Piling, supplied by L. B. Foster Co. was concrete capped, each measured 26 x 3 x 2 ft.



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Light aluminum grating for SUN SHADES on schools is in perfect harmony with modern school design — allows 80% passage of light and air without the accompanying penetrating rays of the sun. Because they are aluminum they are maintenance-free. Furthermore, they provide a permanent working platform for easy access to windows.

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CIVIL ENGINEERING

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VOL. 27 • NO. 6

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William Ginsberg & Associates, New York City, are architects and engineers for the new *Buffalo Evening News* building. Siegfried Construction Co., Inc., of Buffalo, is general contractor.

Steel H-Piles Driven to Bedrock

FOR FOUNDATIONS OF NEW BUILDING IN BUFFALO

Foundation work has been completed for a new steel and brick building in downtown Buffalo, N. Y., to house the printing plant of the *Buffalo Evening News*. The building will contain 158,500 sq ft of space, embodying the most modern developments for newspaper production. Contained in the $7\frac{1}{2}$ million building will be a pressroom 250 ft long and 60 ft wide with a 45 ft ceiling.

Bethlehem Steel H-Piles were used in the foundations. Over 1000 piles, varying in length from 36 to 49 ft, were driven to bedrock in this first phase of construction operations.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation
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Driving Bethlehem H-Piles to bedrock.

Complete design Versatility with standard components

windows

Specify any size or type your design requires. Glass can be clear or patterned, and single or double glazed. Sash can be either fixed or operating in awning, projected, pivoted and hopper types or Robertson's new V-Window (hinged for inside cleaning).

verticals

The verticals as well as all trim can be fabricated from a variety of materials to provide contrast with the spandrels. The vertical members can be fabricated in a number of cross-sections to suit your design requirement.

spandrels

Here again, an infinite number of design and size selections are possible. The V-Panels can have a wide variety of surface patterns and be fabricated in aluminum, bronze, stainless steel, Galbestos or vitreous enameled aluminum or steel. Versatile Wall offers complete freedom of design.

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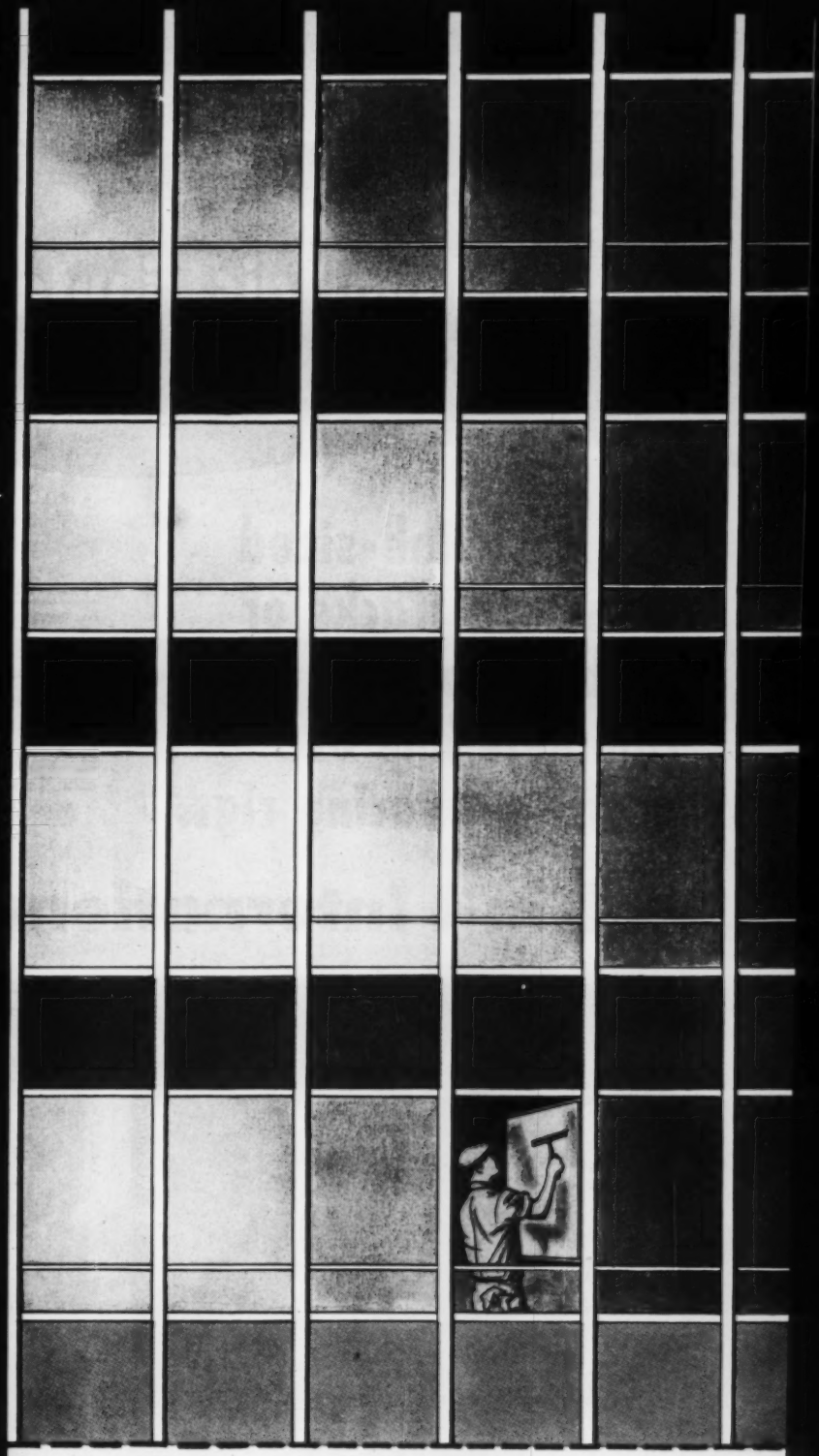

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...a curtain wall as individual as your signature

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Buy your job-sized 4-In-1 on tracks or rubber from a complete line of profit-producing rigs.

Now—why tie-up useful money or "strap" your credit by "over-equipping"? Why spend upwards of four times as much for several limited-duty machines which one 4-In-1 can replace—and outproduce?

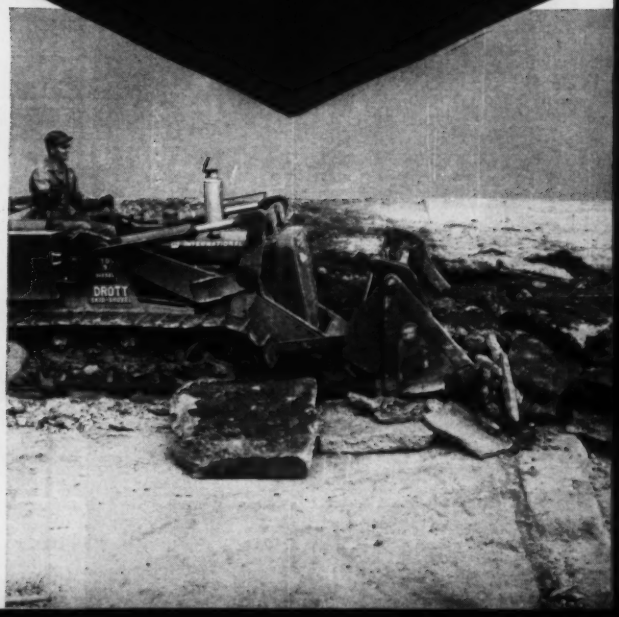
An International Drott 4-In-1 gives you 4-machine usefulness for one moderate investment. Yes, the exclusive and revolutionary 4-In-1 gives you instant availability of 4 big-capacity machine actions!

You get world-beating Skid-Shovel excavating-

All-in-1 International Drott 4-In-1

"Carry-type scraper"

Skid-Shovel...



machine job-capacity
One-machine price!

loading performance. You get exclusive multi-purpose "carry-type scraper" action. You get production-boosting clamshell action. You get "radius-controlled" bulldozer action with big-yardage earth-rolling ability!

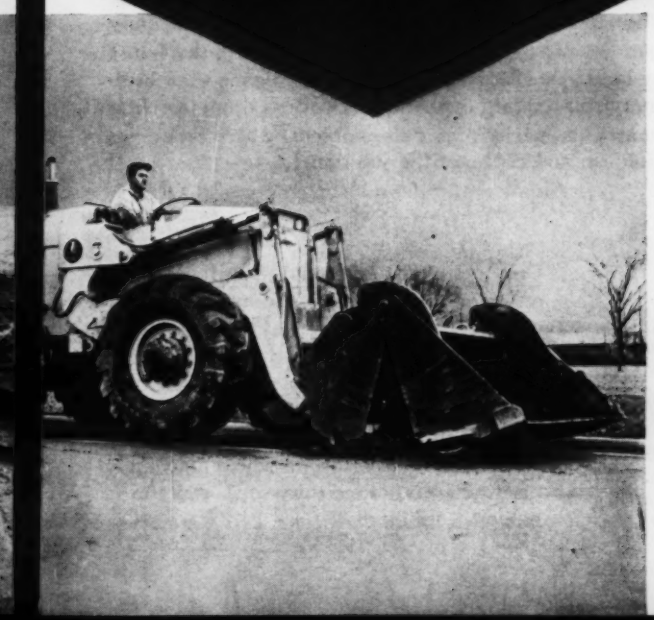
You get 4-In-1 versatility unlimited for a fraction of the price of the machines it can replace and outperform, on job after profitable job!

And you can have 4-In-1 advantages teamed with all-condition International crawler traction, or rubber-tired Hough Payloader speed!

See your International Distributor—he's the only one who can offer you a 4-In-1 deal! He's the only one who can save you the thousands of dollars that 4-In-1 ownership assures—by giving 4-machine utility for one moderate investment. And he can prove the "heap of difference" in 4-In-1 performance on tracks or rubber—against anything else in the field! See him soon for a demonstration!

gives you...

Clamshell...



Bulldozer...

ONLY YOUR International distributor CAN OFFER THESE EXCLUSIVE FEATURES!

Here's job-range.

Exclusive triple-power pry-action break-out

Inbuilt ability to deliver tremendous excavating force enables this TD-9 4-In-1 to yank out deeply embedded old masonry piers. You see typical, on-the-job advantages of true and exclusive International Drott pry-over-shoe break-out action—the only design that gives you the three absolute essentials: (1) Full hydraulic power transfer from full piston-face power-push; (2) Long lever to apply full pry-power; (3) Fixed fulcrum of frame-mounted skid-shoes, to concentrate pry-force!

Exclusive parallelogram raise action

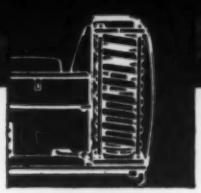
No eccentric tipping to cause spill-back and lose yardage! The 4-In-1 has non-spill, roll-back level—all the way up. Compared to ordinary front-end loader performance, this feature, alone, can increase your daily yardage up to 18%! You can bottom-dump the 4-In-1 as a clamshell...and do it 2½-foot higher than ordinary roll-forward buckets. And bottom dumping eliminates the sticky materials problem—where other rigs foul up and can't get the job done!

Check these other famous International Drott Exclusives!

- **STANDARD EQUIPMENT.** Three-valve design, to provide hydraulic control power for attachments.
- **STANDARD EQUIPMENT.** Double-bottom, bridge-truss bucket to insure 4-In-1 strength to match pry-action.
- **STANDARD EQUIPMENT.** Yoke-type supports to insure linkage strength to back 4-In-1 capacity!
- **STANDARD EQUIPMENT.** Magnetized dip stick to prevent damage to hydraulic system from minute abrasives!

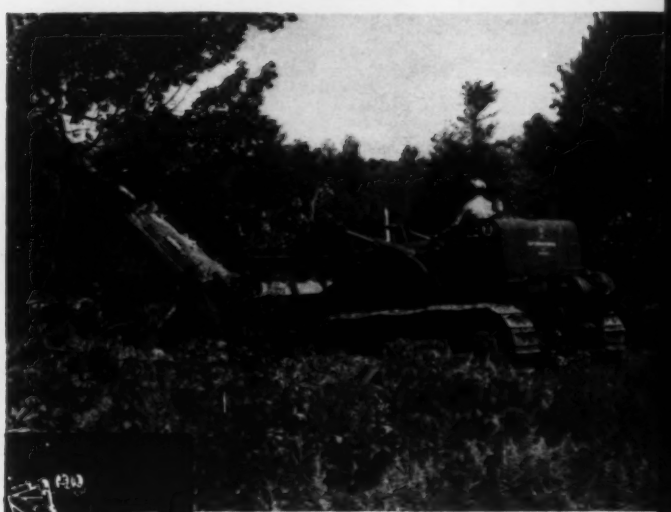
Only your International Distributor can offer you the big money-making advantages of International Drott exclusive 4-In-1 features. Only he can deliver you job versatility unlimited, in the world's only multi-purpose machine of its type! Prove to yourself that your correct size of 4-In-1 can replace and outperform a whole machinery yard full of limited-duty rigs. Ask for a demonstration!

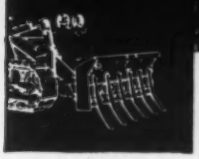
where 4-in-1 gets world-beating . . . capacity . . . stay-put performance!



Exclusive shock-swallowing Hydro-Spring

Capacity-boosting, machine-protecting Hydro-Spring is a hydraulic cylinder enclosed in a heavy-duty locomotive-type coil spring. Shock force displaces oil from main lift cylinders into the Hydro-Spring cylinder—extending it and compressing the big spring to absorb and cushion impact loads. Slamming the 4-In-1 bucket into hard material—'dozing frozen ground—dumping rock with a bang—you never worry! Hydro-Spring gentles trouble-causing forces by two-thirds or more—practically eliminates hydraulic hose failures!





Complete line of attachments

Job-getting, money-making attachments built for specialized duty, provide tree-grubbing, boulder-bucking, log-loading performance available only from International Drott equipment! Grubber Blade attachment, used in place of the 4-In-1, is shown applying the tremendous force of pry-action break-out—to uproot a tough old oak tree. Other special attachments built to extend International Drott advantages to other fields include: Rock Forks, Skid-Grapples®, Bulldozer and Bullangledozer blades!

CHOOSE FROM

four 4-in-1 sizes

TRACTOR SIZE	4-IN-1 CAPACITY
TD-6	1-YARD
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New Highway Construction Requires Pipe, In A Hurry!

AMERICAN
CAST IRON PIPE

The tremendous new highway construction program will require relocation of water, gas, and sewage lines in communities throughout the country.

The relocation of the old Dublin Road Force Main in Columbus, Ohio, is an example.

Speed, both in furnishing pipe and installing it, will be required. Long, trouble-free service, including resistance to impact loads and other stresses as well as resistance to corrosion once the pipe is installed, will also be required.

American Cast Iron Pipe Company service and centrifugally cast pipe meet these requirements:

- **Sales offices and shipping points near you help speed delivery.**
- **Easy-to-assemble, bottle-tight joints help speed installation.**
- **Strength, durability, and corrosion-resistance assure long trouble-free service.**

Specify American Cast Iron Pipe. A call to our Sales Office nearest you will bring both information and assistance.

36" American Double-X Mechanical Joint Pipe, with Enameline lining, being installed in Columbus, Ohio, for water service.

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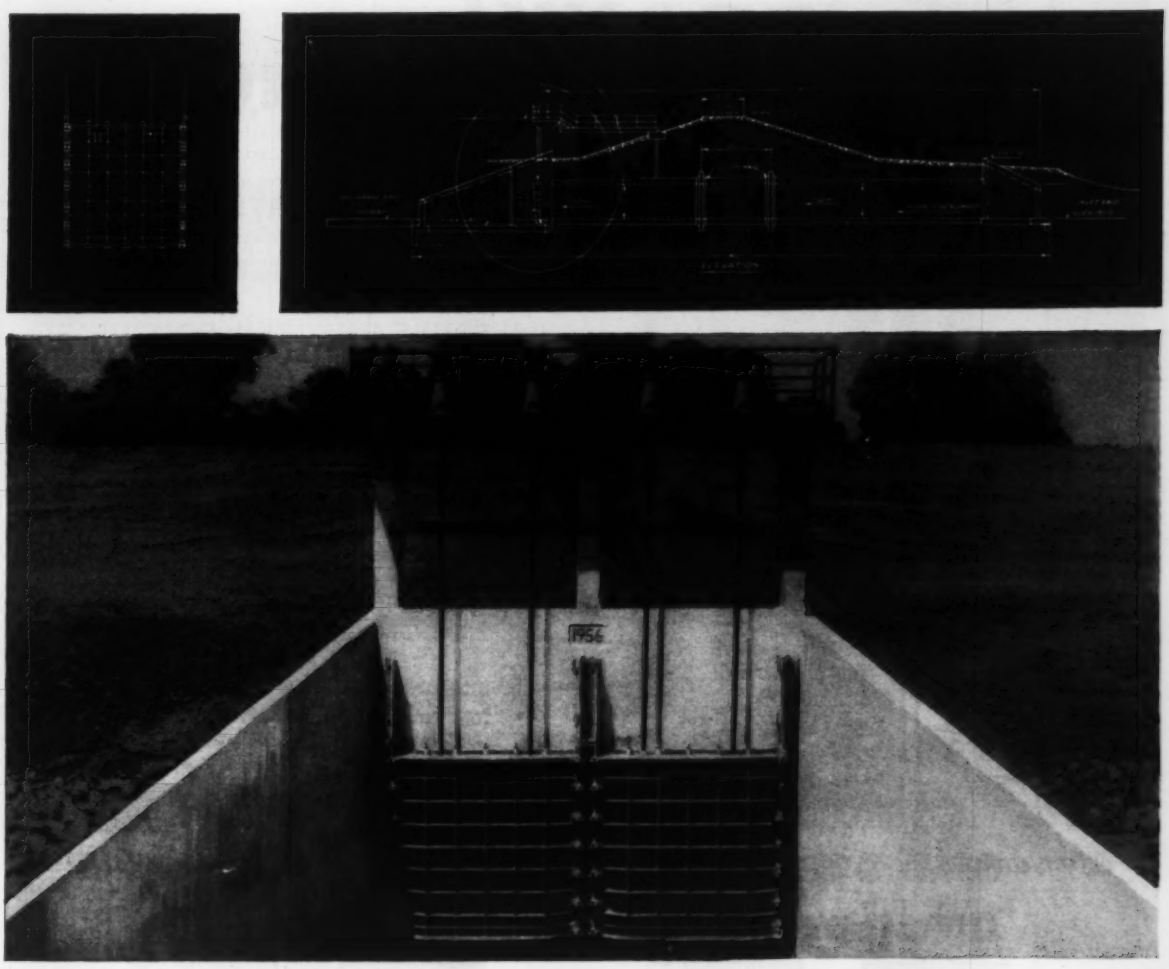


RODNEY HUNT SLUICE GATES ...MAKE THE BAYOU BEHAVE

Water control engineering problems are unique in their profound effect upon human lives, health and prosperity.

In this installation, Rodney Hunt engineering and sluice gate design protect more than 80 square miles of farm land. The gates, when open, allow normal drainage to the Bayou River, and when closed prevent flooding as the river goes to flood stage.

The two Rodney Hunt 10-foot by 10-foot cast iron bronze-mounted sluice gates were designed for maximum opening with minimum structure. The installation is unique because inherently rigid flange frame sluice gates with wall thimbles were installed with attaching studs projecting to the front of the frame. This eliminated the need for excessive side clearance and saved on structural costs. Rodney Hunt also supplied precision-built interconnecting floor stands with twin stems on each gate for balanced, smooth operation.

Projects of such importance demand skilled engineering as well as unquestioned product dependability.

RODNEY HUNT MACHINE CO.

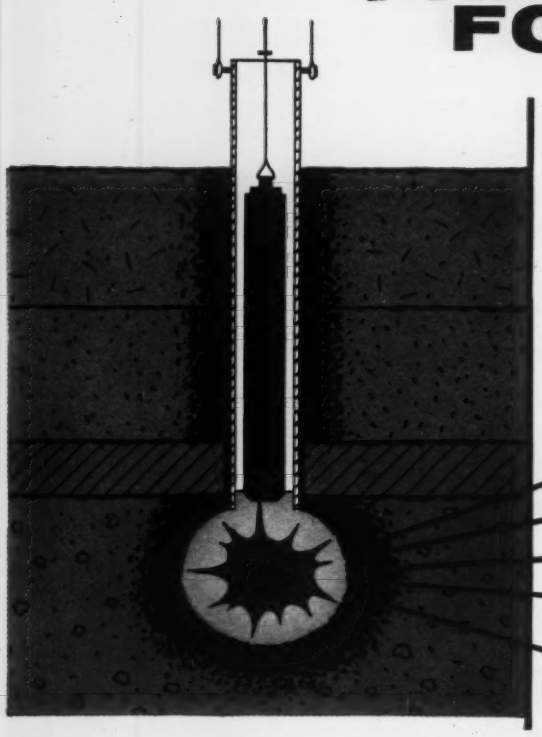
Water Control Equipment Division

86 Lake Street, Orange, Massachusetts, U.S.A.

RODNEY HUNT®

SERVING WATER CONTROL ENGINEERS WITH SLUICE GATES AND ENGINEERING

FRANKI FOUNDATIONS



UNIQUE INSTALLATION METHOD

CREATES

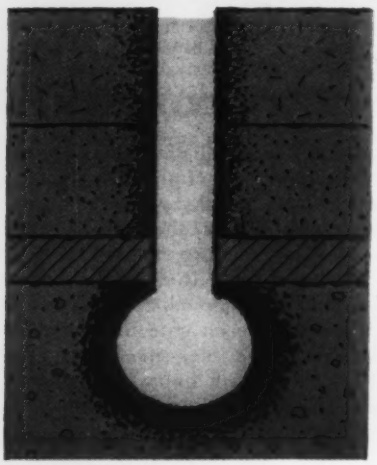
PRESSURE INJECTED FOOTINGS!

compare these advantages with ordinary concrete footings:

- **ZERO SLUMP, "POUNDED IN"** concrete
- **FORGED** by 150,000 FT. LB. blows
- **EXPANDED BASES**—36" to 60" diameter
- **BEARING IN DEPTH** in granular soil or on rock
- **GUARANTEED** to support specified design loads

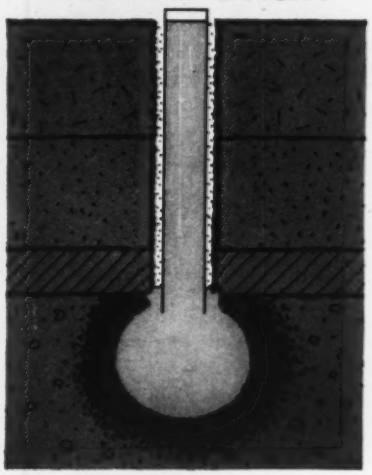
After completion of the pressure injected footing, these two options are available:

UNcased Shaft



Junior High School
Hamden, Connecticut
Warren H. Ashley — Architect
Arthur G. Beaulieu Assoc. — Engineers
The Fusco-Amatruda Co. — Gen'l Contr.

Cased Shaft



Multi-level Parking Facility
City of Worcester, Mass.
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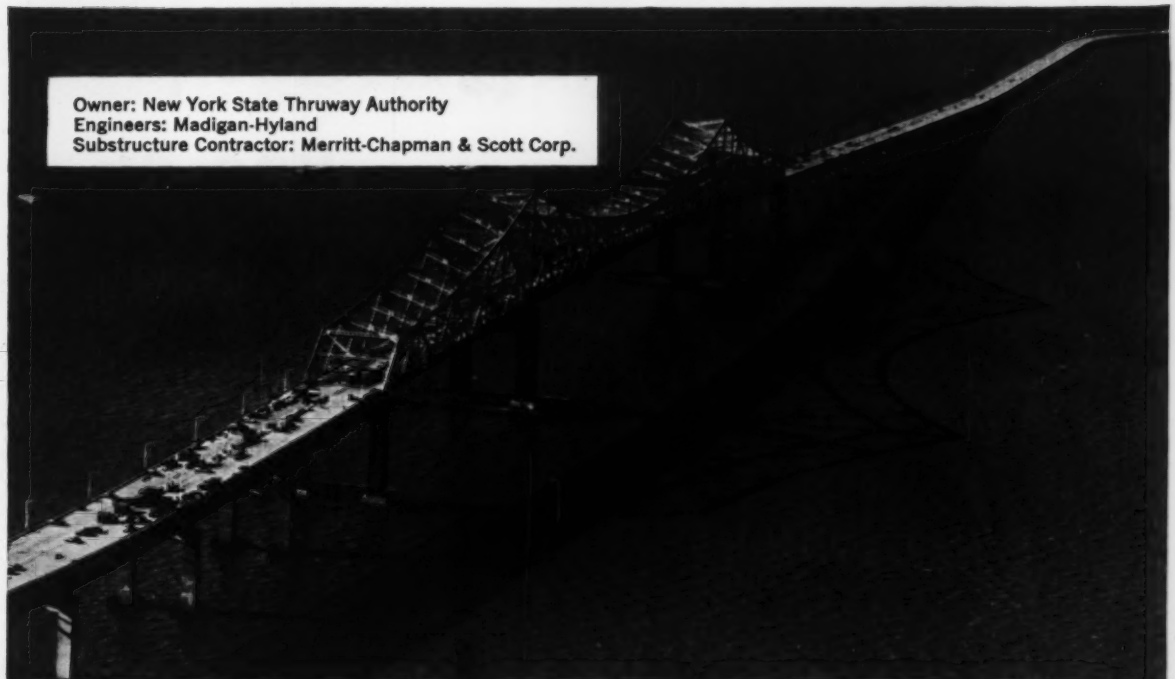
For brochure describing Franki Foundation methods, write to:

FRANKI FOUNDATION COMPANY 103 PARK AVENUE, NEW YORK 17, N. Y.



Owner: New York State Thruway Authority
Engineers: Madigan-Hyland
Substructure Contractor: Merritt-Chapman & Scott Corp.

TAPPAN ZEE BRIDGE:

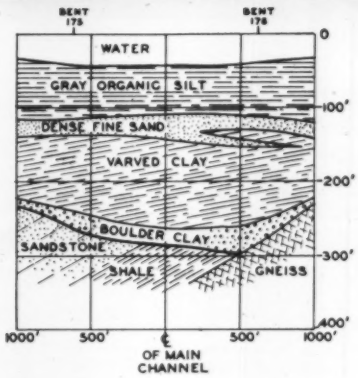
you can't see the toughest problem

Placing the foundations for the center cantilever span of the $60-million Tappan Zee Bridge was a major construction triumph! Featuring buoyant concrete caissons, this famous structure carries the New York Thruway 2.8 miles across the Hudson River from Nyack to Tarrytown.

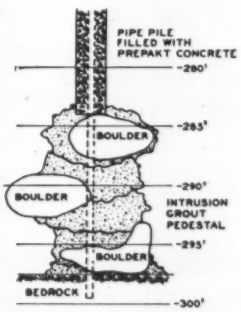
Substructure design called for 30-inch pipe piles to take part of the dead load and all of the live load, but unusual subsoil conditions (diagram) caused unprecedented problems. Boulders and weak bedrock prevented firm pile bearing; 260 to 300-foot piles made tremie concreting impractical. When these conditions were encountered, INTRUSION-PREPAKT was called in.

After airlift mucking, all 146 piles were filled with PREPAKT concrete made by consolidating preplaced aggregate with INTRUSION grout. This was followed by drilling, washing and INTRUSION grouting the area below the piles to provide necessary point-bearing for the piles. This consolidated the seamy gneiss and decomposed sandstone producing a direct, strong connection to bedrock for piles stopped by boulders.

Modern I-P techniques thus were vital to the success and economy of the unique Tappan Zee foundations. When you encounter difficult foundation problems, contact: INTRUSION PREPAKT, INC., Room 568-F, Union Commerce Bldg., Cleveland 14, Ohio. In Canada: INTRUSION-PREPAKT, LTD., 159 Bay St., Toronto, Ontario.



Subsoil profile at Tappan Zee site.



Pedestal build-up with INTRUSION grout supports piles halted above bedrock by boulders. Piles were filled with PREPAKT concrete when great length made other methods impractical.

INTRUSION-PREPAKT, INC.

OFFICES IN PRINCIPAL U. S. AND FOREIGN CITIES

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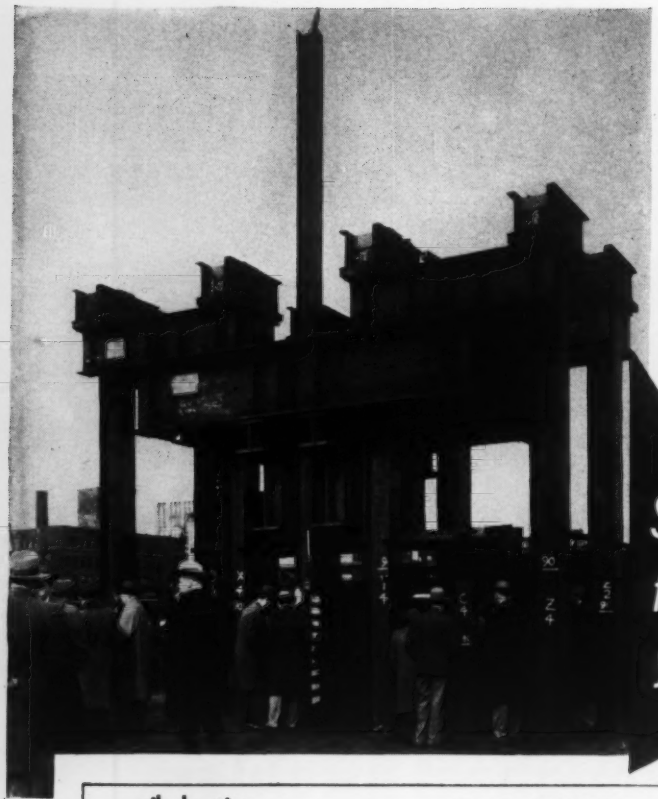
Chicago tests prove USS Steel

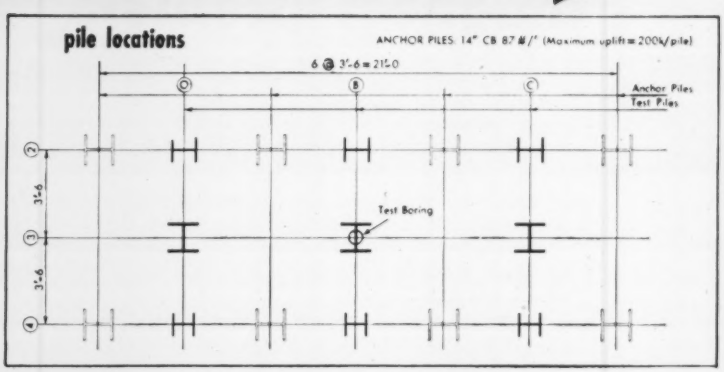


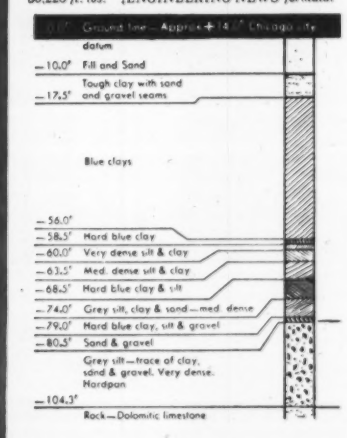
To provide authentic data showing USS steel H-beam piles capable of meeting limits allowed by the City of Chicago Building Code, United States Steel Corporation had the Armour Research Foundation of Illinois Institute of Technology conduct tests on a site having soil conditions typical of the Loop area. Tests were made at the corner of Harrison and Halstead Streets. A total of 17 piles were driven, eight of which were used as anchor piles. Data on the nine test piles is shown in the table below.

USS Steel H-Beam Bearing Pile Test

Pile Number								
Pile Size								
End Conditions								
Proposed Allowable Load—Tons								
Test Load—Tons								
No. of Blows in Last Inch								
Estimated Design Load by ENR Formula‡								
Total Deflection at Proposed Allowable Load								
Total Deflection at Test Load								
Rebound from Test Load								
Total Net Settlement								
Allowable Total Net Settlement by Chicago Code								
Load at Failure—Tons								
Avg. Unit Stress (fs) at Failure—psi								
Total Deflection at Failure								
Rebound from Failure Load								
Net Settlement after Removal of Failure Load								
Manner of Failure								

*Final driving of all piles by Vulcan type OR hammer—30,225 ft. lbs. ‡ENGINEERING NEWS formula.




Ground line—Approx. + 14.0' Chicago datum
—10.0' Fill and Sand
—17.5' Tough clay with sand and gravel seams
Blue clays
—56.0'
—58.5' Hard blue clay
—60.0' Very dense silt & clay
—63.5' Med. dense silt & clay
—68.5' Hard blue clay & silt
—74.0' Grey silt, clay & sand—med. dense
—79.0' Hard blue clay, silt & gravel
—80.5' Sand & gravel
Grey silt—trace of clay, sand & gravel. Very dense. Hardpan
—104.3'
Rock—Dolomitic limestone

THEIR NATURAL ADVANTAGES *make* USS STEEL H-BEAM BEARING PILES

the logical foundation for heavy, multi-story buildings

The design possibilities, low cost, and ease of installation of USS steel H-Beam bearing piles offer definite advantages over foundation caissons for supporting heavy buildings. Buildings of any height can be founded on steel H-Beam piles without limitations resulting from insufficient penetration. Excessive amounts of free water, marsh gas, and other adverse conditions which sometimes halt construction of open-pit caissons, offer no obstacles to obtaining required design loads with steel H-beam bearing piles. Furthermore, the cost in time, materials, and equipment needed to construct open-pit caissons makes USS steel H-Beam Bearing Piles the most economical type of foundation you can use.

SEE THE UNITED STATES STEEL HOUR. It's a full-hour TV program presented every other week by United States Steel. Consult your local newspaper for time and station.

high load-carrying capacity of H-Beam Bearing Piles

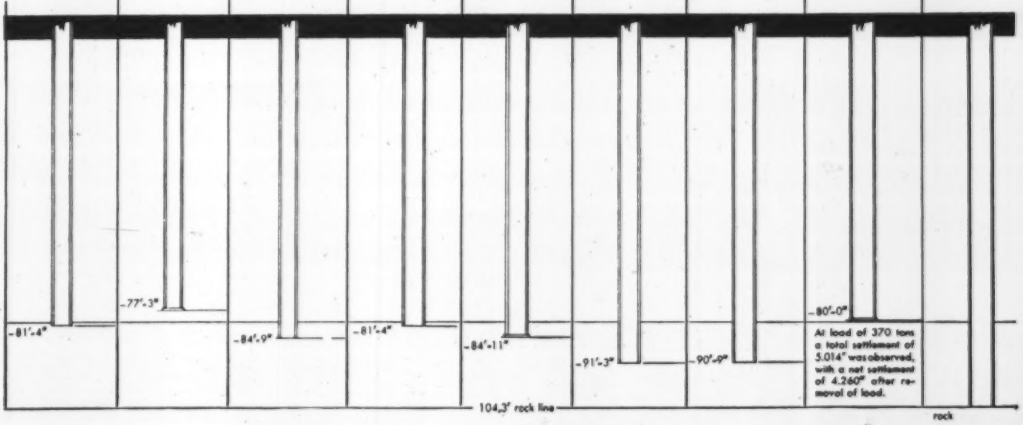
All of the nine piles tested exceeded the requirements of the Chicago Building Code, except for the closed end, 14-inch H-beam bearing pile that failed by excessive net settlement at a load of 370 tons. This pile was not driven to hardpan inasmuch as the desired driving resistance was attained before hardpan was reached. Therefore, it seems logical to assume that for loads of the magnitude of those under discussion, firm seating in hard soil should be a requirement.

Here again is proof that USS Steel H-Beam Bearing Piles are capable of carrying heavy foundation loads into stable mediums lying at great depth. Their capacity for high unit loads, both vertical and horizontal, permits fewer piles and fewer driving operations for a given load. They are readily handled in the field by ordinary equipment, are easy to splice, eliminate jetting, and withstand rough handling.

If you would like to receive detailed information regarding your particular foundation problems, please contact the office nearest you.

Data* (In accordance with Chicago Code requirements—in addition B4, B2 and B3 were tested to failure.)

04	C4	B4	02	C2	B2	03	C1	B3
10" CBP 42 #/'	10" CBP 42 #/'	10" CBP 42 #/'	12" CBP 53 #/'	12" CBP 53 #/'	12" CBP 53 #/'	14" CBP 117 #/'	14" CBP 117 #/'	14" CBP 117 #/'
Open	Closed	Open	Open	Closed	Open	Open	Closed	Open
75	75	75	100	100	100	200	200	200
150	150	150	200	200	200	400	400	400
10	10	31	7	7	Refusal	22	24	On Rock
151	151	228	124	124	.....	208	213	.....
0.317"	0.312"	0.168"	0.359"	0.338"	0.270"	0.378"	0.454"	0.293"
0.773"	0.976"	0.501"	2.147"	1.321"	0.637"	0.891"	See Below	0.695"
0.633"	0.730"	0.549"	0.754"	0.810"	0.670"	0.723"		0.657"
0.140"	0.246"	−0.048"	1.393"	0.511"	−0.033"	0.168"		0.038"
1.50"	1.50"	1.50"	2.00"	2.00"	2.00"	4.00"	4.00"	4.00"
		240			300			635
		34400 psi			38500 psi			36900 psi
		0.985"			1.079"			2.669"
		0.831"			0.932"			1.176"
		0.154"			0.147"			1.493"
		Local Flange Buckling Above Ground			Local Flange Buckling Above Ground			Yielding Over Cross Section of Pile



UNITED STATES STEEL CORPORATION, PITTSBURGH, PA. • COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA. • UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS

UNITED STATES STEEL

BIG YELLOW TEAM KEEPS HOT MIX MOVING AT 150 TONS PER HOUR

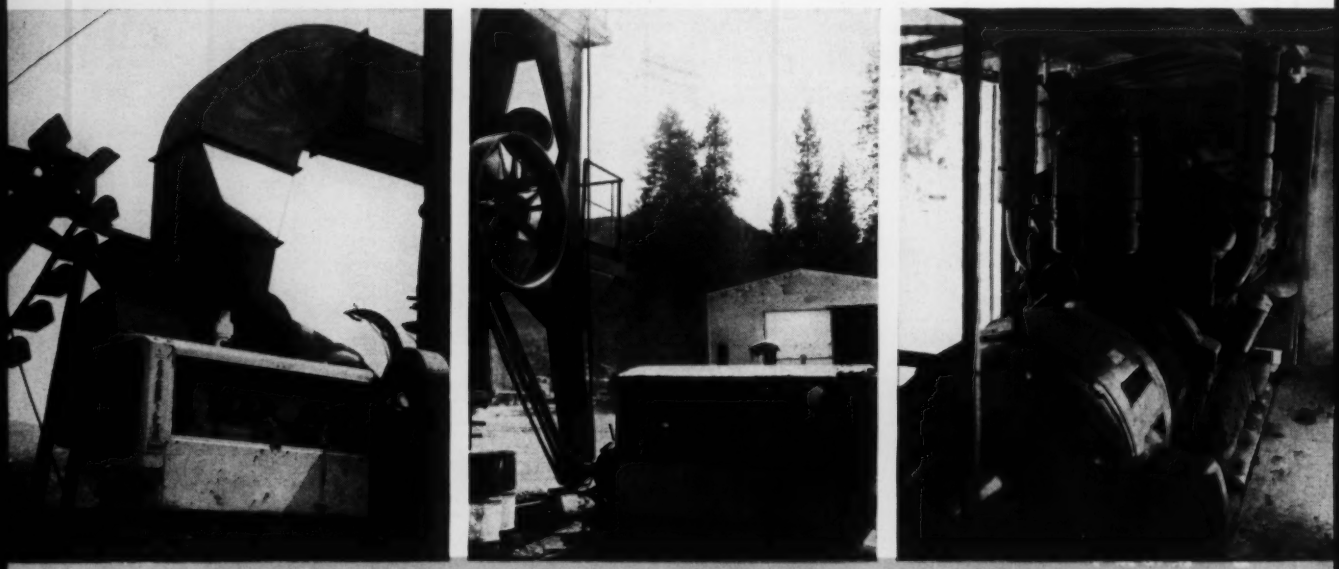
Commonwealth Construction Co., Ltd., of Vancouver, B. C., Canada, depends on Caterpillar equipment for its road building jobs. The pictures shown here were taken near Clearwater, B. C., where 11.3 miles of highway were being surfaced with hot mix.

Included in Commonwealth's big yellow team at the mixing plant are a CAT* D318 Engine that drives the blower, a D342 that drives the mixer and a D364 Electric Set that runs the dryer, bucket line, pumps, burners, lights and conveyors. Hourly production is approximately 150 tons of material.

Power for the portable crusher is supplied by another Caterpillar D342 Engine. A D318 powers the 1-yard dragline that loads the hopper, and a Cat D6 Tractor stockpiles the gravel as it comes from the crushing plant, handling about 1,800 tons a day. The seventh Caterpillar machine in the line-up is a No. 112 Motor Grader, used for scarifying and leveling the road.

Many contractors have found it pays to keep Cat equipment predominant in their spreads. Operators are familiar with Cat-built machines and feel at home with them. Rugged design, good control and ease of maintenance are other qualities which operators like about Cat equipment.

A quarter century of diesel leadership has produced a line of engines that are unbeatable for heavy-duty work. They're built to operate steadily, without fouling, on a wide variety of low-cost fuels, including ordinary No. 2 furnace oil. There are no cylinder ports to clean, and simple, single-orifice fuel injection valves need no cleaning or adjustment. Lubrication schedules are also simplified when all equipment is Caterpillar-built.



Three Cat Diesels power the Standard Steel hot mix plant: A D318, left; D342, center; and a D364 Electric Set, right.

This D342 Engine drives the Pioneer portable crusher. In background, working on the gravel stockpile, is a Caterpillar D6 Tractor.

One of the most important factors in standardization is the availability of prompt, efficient service on all machines from a single, responsible source—your Caterpillar Dealer.

He has facts and figures to prove the dollars-and-cents advantages of making Cat equipment the backbone of your spread. And he backs the long work life of that equipment with reliable service and Caterpillar parts you can trust.

Caterpillar Tractor Co., Peoria, Illinois, U. S. A.

CATERPILLAR*

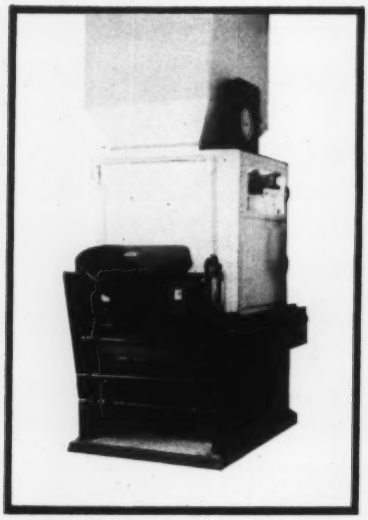
*Caterpillar and Cat are Registered Trademarks of Caterpillar Tractor Co.

The Koehring dragline, with 1-yard bucket, is powered by a Cat D318 Engine.

A Caterpillar No. 112 Motor Grader scarifies and grades road surface before asphalt mix is laid.

FEEDING LIME?

...It's Omega Time!



FOR FEEDING AND SLAKING QUICKLIME IN LARGE PLANTS

Omega Lime Slaker with Loss-In-Weight Feeder

Accuracy — within ±1% of set feed rate (by weight)

Capacity — 50 to 12,000 lbs./hr.

Feed range — up to 100 to 1 on feeder . . . 10 to 1 on slaker

FOR FEEDING LIME SLURRY IN LARGE PLANTS

Omega Rotodip Liquid Feeder

Accuracy — within ±1% of calibrated rate

Capacity — maximum rates up to 1800 gph

Feed range — up to 100 to 1

FOR FEEDING HYDRATED LIME . . .

Omega Loss-In-Weight Feeder, Model 30

Accuracy — within ±1% (by weight) of set feed rate

Capacity — up to 2000 lbs./hr.

Feed range — as high as 100 to 1 if necessary

Omega Universal Feeder

Accuracy — within ±3% to 5% by weight

Capacity — 3 sizes for feed rates up to 5000 lbs./hr.

Feed range — up to 40 to 1 for any specific application

Omega Model 50A Disc Feeder

Accuracy — within ±3% to 5% by weight

Capacity — from 20 to 1700 cu. in./hr.

Feed range — up to 10 to 1 . . . any one of three change gears.

If you're feeding lime . . . quicklime, hydrated lime or dolomite, as a slurry or dry, at low or high rates . . . and want to do it economically, accurately, and dependably . . . investigate the advantages of Omega Feeders. For specific recommendations, send complete details of your feeding requirements . . . to

Omega Machine Co., 360 Harris Avenue, Providence 1, R. I.

OMEGA MACHINE CO.
DIVISION OF
B-I-F INDUSTRIES
BIF METERS FEEDERS CONTROLS

TEETH AT BOTH ENDS* BOOST PROFIT!

Production really steps up when this working team moves in—the Allis-Chalmers HD-6G tractor shovel with replaceable bucket teeth and rear-mounted ripper. Here's a job-proved combination engineered by the company that pioneered modern tractor shovels for the construction industry.

When the hydraulically controlled ripper bites in, even hard blacktop has to give. With the help of teeth at the front end, too, tough material is loosened and broken up for fast, easy loading—a full bucket every time.

You get more work done in less time because the heavy-duty HD-6G is designed for tough jobs. With 72 net engine hp and six-truck-wheel stability, it offers performance that means efficient production, bigger profits for every hour on the job.

These important advantages are also available on bigger Allis-Chalmers tractor shovels—the 2½-yd HD-11G, the 3-yd HD-16G, and the 4-yd HD-21G . . . to help you meet the needs of your tractor shovel jobs profitably. Allis-Chalmers, Construction Machinery Division, Milwaukee 1, Wisconsin.

ALLIS-CHALMERS *Engineering in Action*

slips on like

U.S. PIPE **FOR WATER, SEWERAGE AND**

an old shoe

But once *in*, our revolutionary new "Tyton Joint" pipe seals bottle-tight. Hydrostatic tests on restrained "Tyton Joints" show that they will withstand pressures well in excess of hydrostatic test pressures required by the pipe specifications.

And only *one* accessory needed...a simple rubber gasket. This gasket fits into the bell end, and the connecting pipe compresses the gasket and seals the joint permanently. No bell holes. No delays. "Tyton Joint" pipe can be laid in rain or a wet trench. And even the newest crew can handle it.

Like full information on "Tyton Joint" pipe whose installation is simple, speedy and sure? Call or write us today and get the facts that will save you time, trouble, money in the trench.

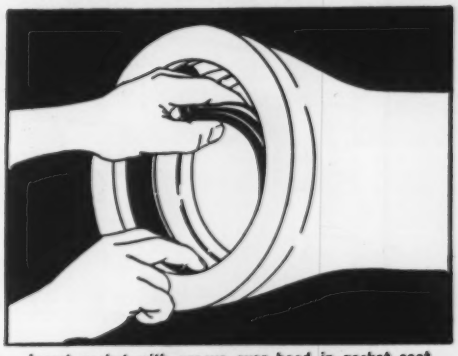
U. S. PIPE AND FOUNDRY COMPANY
General Office: Birmingham 2, Alabama

A WHOLLY INTEGRATED PRODUCER FROM MINES AND BLAST FURNACES TO FINISHED PIPE

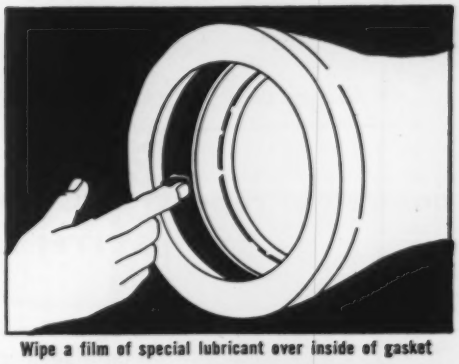
INDUSTRIAL SERVICE CAST IRON

TYTON

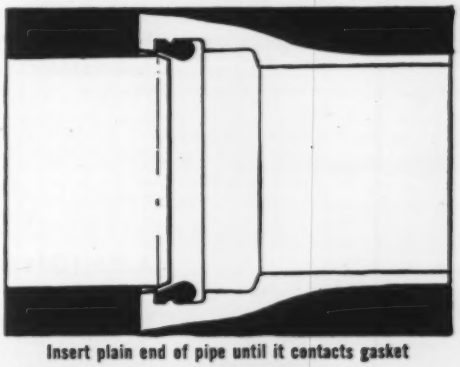
ONLY FOUR SIMPLE ACTIONS



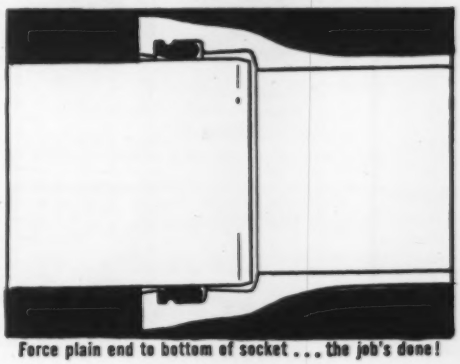
Insert gasket with groove over bead in gasket seat



Wipe a film of special lubricant over inside of gasket



Insert plain end of pipe until it contacts gasket



Force plain end to bottom of socket . . . the job's done!

The new Farmers Union Central Exchange Office Building at South St. Paul, Minnesota. LEHIGH MORTAR CEMENT was used with brick, concrete block, glazed tile, tile and granite.

contractor reports ECONOMY, SPEED, QUALITY
WITH LEHIGH CEMENTS

"As you know," writes Mr. Frank Cahill of Graus Construction Company, "we are subject to long and very cold winters. Therefore, we chose to use Lehigh Early Strength Cement on this job. It proved to be an excellent choice as we were able to eliminate costly overtime in finishing, reduce curing time and put finished concrete into early use.

"For all masonry, we used Lehigh Mortar Cement. As masonry foreman Mike Christenson says. 'Lehigh Mortar Cement performs well in any weather and excells in workability and high bond strength.'"

Whatever your cement requirements, there are Lehigh Cements to help you produce quality work with speed and economy.

- LEHIGH EARLY STRENGTH CEMENT
- LEHIGH PORTLAND CEMENT
- LEHIGH MORTAR CEMENT
- LEHIGH AIR-ENTRAINING CEMENT

LEHIGH PORTLAND CEMENT CO. *Allentown, Pa.*

ARCHITECT:
Ellerbe & Company, St. Paul, Minnesota

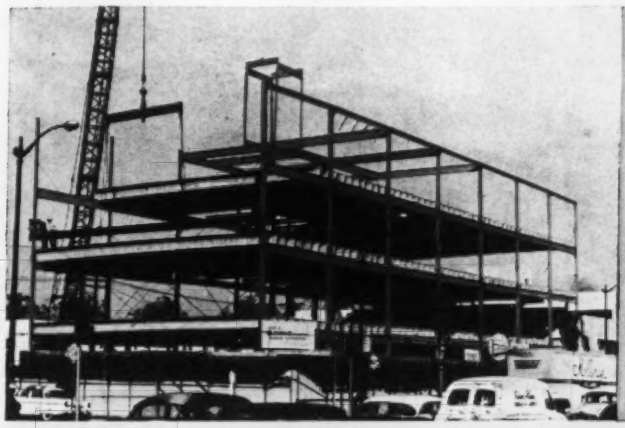
CONTRACTOR:
Graus Construction Co., Hastings, Minn.

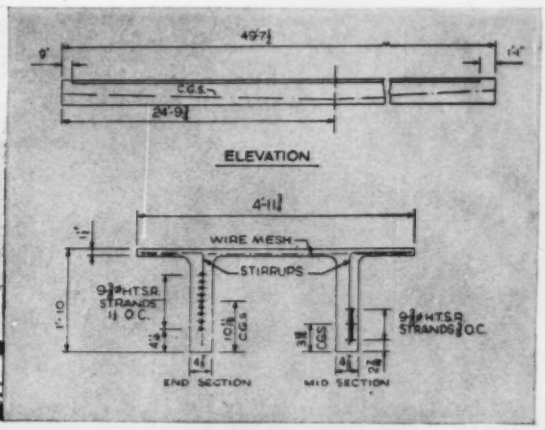
SUPPLIER OF MORTAR AND READY MIX CONCRETE:
Standard Building Material Co., South St. Paul, Minn.

Placing concrete floor made with LEHIGH EARLY STRENGTH CEMENT. Quick-curing concrete permitted early use of this floor for storage of construction materials.

Prestressed concrete floor members with deflected strands were used in this Beverly Hills, California, 4-story office building. Steel plates cast in the concrete members were welded to the steel frame, so that the floor system serves as a diaphragm to stiffen the entire structure.

Each double-tee floor section is five feet wide x 22 in. deep and prestressed with 18 Roebling ⅜ in. diameter 7-wire uncoated stress-relieved prestressed concrete strands. A 2 in. poured-in-place slab on top of the precast section completes the structure. The 49-foot span is designed for 50 pounds per sq ft live load, plus 20 pounds per sq ft for walls and partitions.





Architects and Engineers
Cejay Parsons and Jack H. MacDonald

General Contractor
Jack H. MacDonald Co., Inc.

Prestressed Concrete Double-Tee Floor Sections
fabricated by
Rockwin Prestressed Concrete Corporation
Norwalk, California

Deflected Strands Increase Scope of Precast Prestressed Concrete

New technique permits longer spans with shallower and lighter beams; opens new areas for application of modern construction medium

Recently developed methods have added new impetus to the rapidly increasing use of precast pretensioned bonded prestressed concrete.

One of the most important of these new developments is deflection of the strands. This substantially increases the strength and bending resistance of a member without increasing its size.

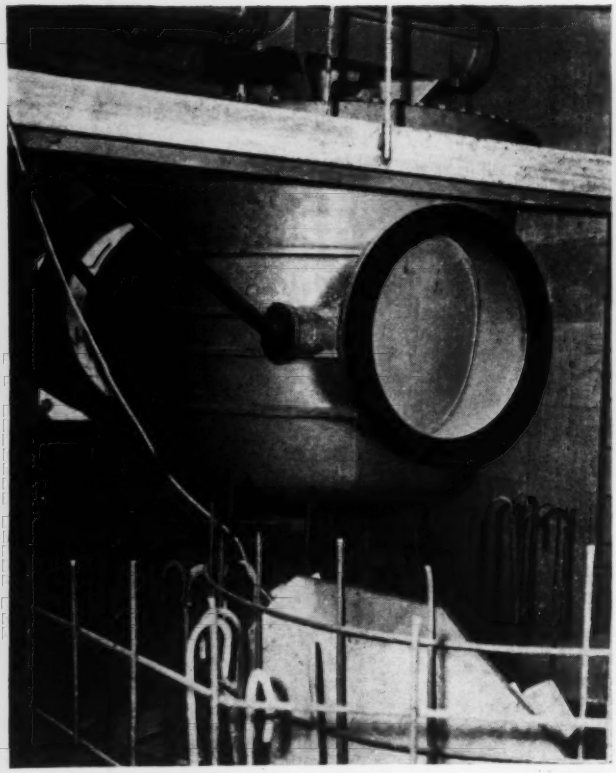
A typical example is the 49 ft 7½ in. span floor system in the building illustrated above, using double-tee beams only 22 in. deep. Units for this span and load would have had to be much deeper and heavier if the prestressed strands were not deflected.

For data on tensioning elements and general information on prestressed concrete, write Construction Materials Division, John A. Roebling's Sons Corporation, Trenton 2, New Jersey.

Consult Roebling First . . . First in the U.S. with prestressing and tensioning elements

ROEBLING

Branch Offices in Principal Cities
Subsidiary of The Colorado Fuel and Iron Corporation



Downhill view from Iron Mountain tunnel inlet shows first two conduits and pumping station, with reservoir and aqueduct in background. Excavation at right of pumping station will house third set of pumps, and third conduit will be added.

This SMS-Rotovalve at Iron Mountain shows clearly the drop-tight shut-off position. In operation, the conical plug first lifts, then turns, finally reseats, giving you precise aperture control.

3 MORE SMS-ROTOVALVES ORDERED FOR PUMP DISCHARGE SERVICE AT IRON MOUNTAIN

As part of the expansion program for increasing the supply of water to southern California through the Colorado River aqueduct, three more SMS-Rotovalves have been ordered by the Metropolitan Water District of Southern California. These three 48″ x 64¼″ tapered Rotovalves, duplicates of six already installed at Iron Mountain Pumping Station, will be used for pump discharge service. Their inherent characteristics of a large reduction of flow area during the early part of the closing stroke make them ideally suited to control of surges in the event of emergency shut-off.

SMS-Rotovalves give the least possible pressure loss. In the open position, their full line opening offers no more resistance than a straight piece of pipe of the same diameter. Hydraulic unbalance and mechanical design make operation easy, and less powerful operators may be used. Rotovalves' flexibility suits them to any type of operation, any method of control, or any sort of location.

To obtain information on SMS-Rotovalves, as well as on the entire SMS line of Butterfly and Ball Valves, contact our nearest representative, or write S. Morgan Smith Company, York, Pennsylvania.

S. MORGAN SMITH HYDRODYNAMICS

AFFILIATE: S. MORGAN SMITH, CANADA, LIMITED, TORONTO

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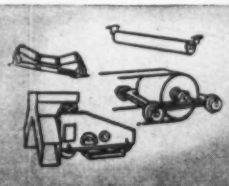
Rotovalves • Ball Valves • R-S Butterfly Valves • Free-Discharge Valves • Liquid Heaters • Pumps • Hydraulic Turbines & Accessories

WHAT BUT A BELT CONVEYOR could carry this load for so few pennies a ton? Moving at high speed—24 hours a day if required—belt conveyors handle huge tonnages in a continuous stream. Loading and unloading delays are eliminated, and there's no time lost on empty return runs. Operating costs are relatively low, based on cost per ton handled. In fact, economies of belt conveyor operation and upkeep generally top any other form of bulk material transportation. And thanks to their extreme flexibility, installation is easy even in difficult locations.

WHO BUT LINK-BELT offers such a complete belt conveyor service? For any requirement—new installation or modernization job—Link-Belt will plan it, equip it, erect it and stand behind it. Our engineers can choose from industry's most comprehensive idler line—plus a broad range of pulleys, drives, terminal machinery and auxiliary equipment. Because all drawings and equipment come from one source, responsibility is centralized . . . no need to waste valuable engineering man-hours coordinating drawings from several sources.

OVERALL ENGINEERING



COMPLETE EQUIPMENT

SKILLED ERECTION

ASSURED SATISFACTORY PERFORMANCE

Add to the basic economies of belt conveyors the extra advantages offered by Link-Belt—it's a formula producing lower costs per ton for all industry. Your nearby Link-Belt office can furnish complete information. 14,821

LINK-BELT

BELT CONVEYOR EQUIPMENT

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville (Sydney), N.S.W.; South Africa, Springs.

KANSAS TURNPIKE Self widener purchased for use on Kansas City, Missouri, Freeway interchanges—built in flexibility made use on Kansas Turnpike equally profitable.

Again Flex-Plane has the nation's number one finisher

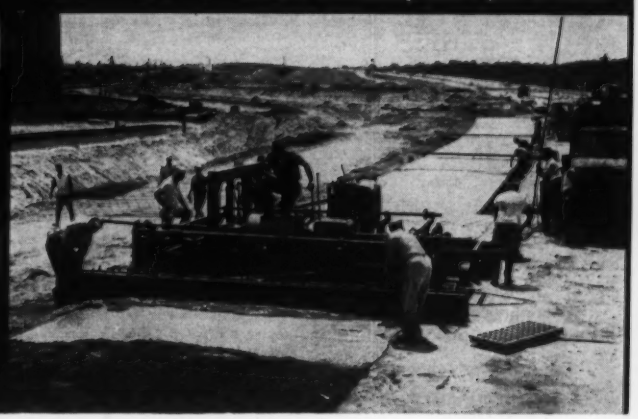
For the past three years, contractors have bought more Flex-Planes than all other makes — They will again in 1957...here's why

From the moment the FLEX-PLANE finisher was introduced it has been the favorite of the nation's highway builders. For the past three years it has been in a class by itself—the most versatile, most flexible, most portable and least expensive to operate of any machine on forms.

Now, for 1957, the FLEX-PLANE finisher is even

INDIANA TURNPIKE More miles of Indiana Turnpike were finished with Flex-Plane machines than any other.

NEW JERSEY TURNPIKE Holland Tunnel cutoff had many ramps and intersections. Self-widening feature paid dividends.



TEXAS CITY STREETS Contractor reported highest pouring ever. Credits Flex-Plane. Note amount of concrete in front of screed here.

better! It is more flexible, stronger and faster than ever! Inherent frame design features allow the greatest amount of flexibility—*even as much as 12 to 25 feet in one machine!* And, there is a complete line of FLEX-PLANES to cover any width range desired. Only FLEX-PLANE self-widening offers independent control of extension frames, which means both sides of the machine can be extended or retracted together—*or individually*, for the negotiation of complicated interchange patterns involving variable width and short radius super elevated curves. But, more important, it is the only really proved self-widening machine available today. More than 60 units operating throughout the nation attest to this.

The FLEX-PLANE carries the largest screeds in the industry-delivering the most satisfactory finish possible. Exclusive butt joint screed design enables screed lengths to be changed faster, easier than ever before. It is completely portable—a flick of the finger and it, instantaneously, becomes its own trailer.

Why not let FLEX-PLANE put you in contact with a FLEX-PLANE user? Talk to him and we are sure you, too, will GO FLEX-PLANE IN 1957!

GARDEN STATE PARKWAY Contractor watched machine operate on nearby Route 1 project. Bought immediately.

THE FLEXIBLE ROAD JOINT MACHINE COMPANY
514 THOMAS ROAD · WARREN, OHIO

261

NEWS OF ENGINEERS

C. Maxwell Stanley, senior partner and manager of the Stanley Engineering Company, Muscatine, Iowa, joins the growing list of engineer authors writing on non-technical subjects. Entitled "Waging Peace," Mr. Stanley's thought-provoking book presents a seven-point program for maintaining peace. Mr. Stanley has received a number of awards, including ASCE's Collingwood Prize for Juniors; the Alfred Noble Prize, a joint engineering society award; and the Iowa Engineering Society's John Dunlap Prize and Marston Award.

Eugene P. Fortson, Jr., chief of the Hydraulics Division of the Waterways Experiment Station, Vicksburg, Miss., has been elected to alumni membership in Tau Beta Pi's chapter at Texas A & M College. The honor was presented to Mr. Fortson on the 25th anniversary of his graduation for his "outstanding achievements in the field of engineering." Mr. Fortson is a veteran employee of the Waterways Experiment Station, with which he became connected in 1932.

Eugene P. Fortson

James D. Bucher and **Shelby K. Willis** have established a consulting engineering practice under the firm name of Bucher & Willis, with offices in the Manufacturers Exchange Building, Kansas City, Mo. The firm will specialize in the design of highways, bridges, and structures.

Jerold B. Van Faasen was recently appointed resident engineer for the special Projects Office of the Seattle District of the Corps of Engineers. Mr. Van Faasen transferred to the Seattle District in 1951 from the Fort Peck (Mont.) District. He has been with the Corps since 1935.

Bernal H. Swab has joined O'Brien & Gere, consulting engineers and land surveyors, Syracuse, N. Y. Until recently Mr. Swab was consulting engineer on utility studies to Gulf Securities of Louisiana, Inc., and International Associated Engineers, Inc., New Orleans, La.

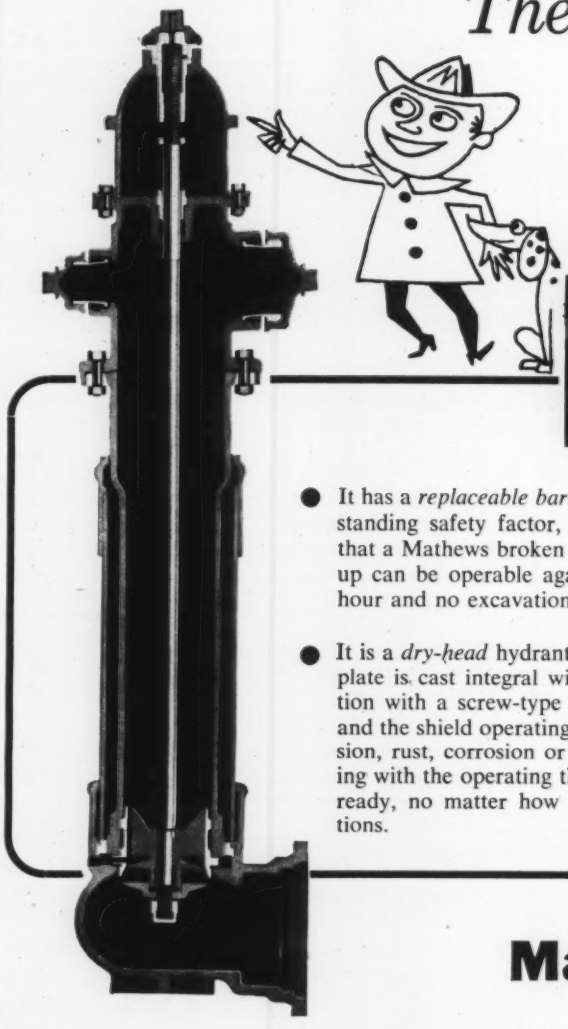
Two Society members were among six Bureau of Reclamation employees recently honored with the Distinguished Service Award, the highest honor the Department of the Interior can bestow. Recipients were **Grant Bloodgood,** chief construction engineer who has been with the Bureau since 1920; and **Arthur B. Reeves,** retired chief of the Irrigations operations Division, who has served the Bureau for 43 years.

C. J. Maupin, since 1942 chief arsenal engineer for the Pine Bluff Arsenal, Arsenal, Ark., has become executive officer to the commanding officer. Earlier in his career he was in the engineering department of the St. Louis Southwestern (Cotton Belt) Railway.

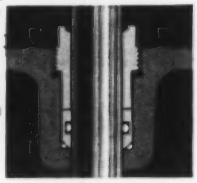
Robert E. Shaver, professor of civil engineering at the University of Kentucky, has been promoted to dean of the College of Engineering. Mr. Shaver assumes his new duties in July.

MATHEWS

The finest



O-Ring seal available when specified



- It has a *replaceable barrel.* This is an outstanding safety factor, because it means that a Mathews broken in a traffic smash-up can be operable again within half an hour and no excavation is necessary.
- It is a *dry-head* hydrant. The stuffing box plate is cast integral with the nozzle section with a screw-type stuffing box. This and the shield operating nut prevent abrasion, rust, corrosion or ice from interfering with the operating thread. It is always ready, no matter how severe the conditions.

Made by

Frederick T. Mavis, since 1944 head of the civil engineering department at Carnegie Institute of Technology, has been made dean of the University of Maryland's College of Engineering. In his new capacity, Dr. Mavis will succeed **Dr. S. S. Steinberg,** who resigned last October. Before joining the Carnegie faculty he was professor and head of the civil engineering department at Pennsylvania State College.

Frederick Mavis

Royden E. Reed is retiring in June after approximately 20 years under Federal Civil Service. For the past six years Mr. Royden has been with the U. S. Air Force in the field of procurement and production, stationed at San Antonio Air Materiel Area, Kelly Air Force Base, San Antonio, Tex. He has been deputy chief of the Contract Administration Division, Directorate of Procurement and Production, and acting executive officer of that Directorate at San Antonio.

HYDRANTS...

community protection by design

If you sat down and checked off the features that a well-designed hydrant ought to possess, you would find yourself describing a Mathews Modernized Hydrant

- The main compression-type valve opens *against* water pressure. The higher the pressure, the tighter the valve—a positively leakproof construction.

- **OTHER QUALITY FEATURES**

The operating thread cannot be bent. Head revolves 360°. Nozzle sections can easily be changed. Nozzle level can be raised or lowered without excavation. Bell, mechanical-joint or flange-type pipe connections.

R. D. WOOD COMPANY

Public Ledger Building, Independence Square • Philadelphia 5, Pa.

Manufacturers of Mathews Hydrants and "Sand-Spun" Pipe (centrifugally cast in sand molds)

Harry Elmo Bovay, Jr. of the H. E. Bovay, Jr. consulting engineering firm of Houston, Tex., announces the merger of his company and that of the Reg F. Taylor firm. The new company will continue under the name of H. E. Bovay and will maintain that firms offices. Partners in the Bovay firm, in addition to Mr. Bovay, are **Bennett W. Burns, C. A. Lawler, Richard D. Robertson,** and **W. N. Pauley.**

Russell Quinn has been appointed city engineer of Fairmont, W. Va. Mr. Quinn is a veteran of 28 years of service with the West Virginia State Road Commission and has been connected for the past year and a half with the Frank D. McEnteer, consulting engineering firm of Clarksburg. He is a former president of the West Virginia Section.

K. Gregory Karekin, until recently assistant branch head of the Maintenance and Operation Branch, Department of the Navy, Washington, D. C., is now associated with the District Public Works Office, First Naval District, Boston, Mass. Mr. Karekin is project manager for the Capehart Housing Program of the First Naval District.

Robert B. Hickok, since 1934 project supervisor with the U. S. Department of Agriculture's Research Service, has joined the engineering firm of Holmes and Narver, Inc., Los Angeles, Calif. In his new capacity he will serve as project engineer.

John T. Gaffey, II, Major, U. S. Air Force and installation engineer at Webb Air Force Base, Tex., has been reassigned to the installation engineer office at Thule Air Base, Greenland. He will serve as operations officer.

John R. Hardin, Major General, U. S. Army, retired this month after more than 38 years of service in the Corps of Engineers. Since 1953 General Hardin has been president of the Mississippi River Commission and division engineer of the Lower Mississippi Valley division at Vicksburg, Miss. Earlier he served as division engineer of the Great Lakes Division, chief of the Rivers and Harbors Section, executive officer in the Construction Division, and as assistant chief of engineers for military construction.

General Hardin

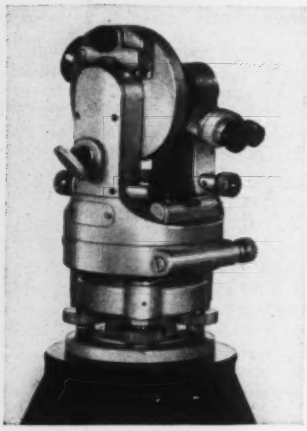
W. McKee Green is opening an office as structural engineer and consultant in Greenville, S. C., after 32 years in varied construction work. Since 1945 Mr. Green

(Continued on page 30)

SURVEYING NEWS

NEW THEODOLITE SETS UP QUICKLY, EVEN IN THE WIND

Has this been your problem? Now—old-type mechanical plumb-bob replaced by can't-miss optical principle



- **Improved Theodolite reads horizontal and vertical circles simultaneously, through same eyepiece**
- **Reads direct to 1 min. with no matching of lines—no parallax**
- **Amazingly blur-free—small, compact, moisture-proof, dust-proof.**

Mail this coupon for details

FENNEL

INSTRUMENT CORP. OF AMERICA
45-22 Pearson St., Long Island City, N.Y.

Please send me Booklet D with information on Fennel . . .

- ☐ Double bubble
- ☐ Other levels
- ☐ Transits
- ☐ Combinations
- ☐ Theodolites
- ☐ Alidades
- ☐ Collimeters
- ☐ Stands
- ☐ Tripods
- ☐ Repair of present instruments, (any make)

NAME.....

ADDRESS.....

.....

News of Engineers

(Continued from page 29)

has been with the J. E. Sirrine Co., Greenville, S. C., working on pulp and paper projects. For a number of years prior to that he was with the Virginia Bridge and Iron Co. on fabricating work.

G. H. Mandeville

Gilbert Harrison Mandeville, since 1952 vice-president and executive director of the Leo A. Daly Company, with offices in Omaha, Nebr., and Seattle, Wash., is opening his own firm in Seattle. The new company, an engineering and architectural firm with offices in the Joseph Vance Building, will be called Gilbert H. Mandeville, consulting engineers.

David B. Steinman, New York City consulting engineer, has been awarded two new honors for his distinguished bridge designs. One of these is the J. Lloyd Kimbrough Medal presented by the American Institute of Steel Construction for "outstanding contributions in the construction of steel structures." The other is the Gzowski Medal of the Engineering Institute of Canada, which cited Dr. Steinman for a paper on the design of the Mackinac Bridge.

Two changes have taken place in the Prescon Corporation, Corpus Christi, Tex. **Loris L. Gerber,** vice-president of the firm, has been transferred to Denver, Colo., as manager of Prescon's Rocky Mountain Division. He will be succeeded by **Ben W. Young,** who has been chief engineer of the company's main office.

William H. Hall has been made an associate in the firm of Warren & Van Praag, Inc., Decatur, Ill., with which he has been connected since 1951. Earlier Mr. Hall was an engineer for the Oklahoma Highway Department, assistant city engineer of Oklahoma City, and associate professor of civil and architectural engineering for Oklahoma A & M College.

Leo J. Ritter, Jr., a lecturer in Transportation Engineering at the Technological Institute, Northwestern University, has been appointed editor of *Modern Highways,* a new highway contractors magazine published by the Scranton Publishing Company, Inc., of Chicago. Professor Ritter, co-author of *Highway Engineering* is known for his column, "Up Front for Better Roads", published in *Public Works Magazine.*

Raymond J. Rosenberger, of Bay Village, Ohio, is now associated with **Willard F. Schade** and **Charles M. Gard** in the Cleveland consulting firm of Willard F. Schade and Associates. Mr. Rosenberger was formerly specification division chief of the H. K. Ferguson Company, Cleveland manager for Gilbert Associates, Inc., and specification engineer for the J. E. Greiner Company.

Milton G. Leong, former senior structural engineer for the California State Division of Architecture, San Francisco, Calif., announces the opening of offices for the general practice of consulting civil and structural engineering under the firm name, Milton G. Leong and Associates. The firm's offices will be at 2140 Shattuck Ave., Berkeley and 333 Maryland Street, Vallejo, Calif.

K. R. Scurr, state bridge engineer for the South Dakota Department of Highways, Pierre, S. Dak., has been awarded a Certificate of Meritorious Service as an outstanding state engineer by the State School of Mines and Technology at Rapid City. The award was made during an Honors Day Convocation in April. Mr. Scurr has been with the Bridge Department since its organization in 1920.

Elbert C. Brown, district engineer for California for the U. S. Bureau of Public Roads and pioneer highway engineer, has retired after 38 years with the Bureau and 48 years in government service. Mr. Brown was with the Bureau of Reclamation on the Shoshone Project and with the War Department in the Philippines before joining the Bureau of Public Roads in 1919. In 1942 he was assigned to work in California, and in 1945 he became district engineer, with headquarters at Sacramento.

Richard Joseph Frazier, production manager for the Anchor Concrete Products Co., Buffalo, N. Y., has been promoted to vice-president-director of production for the company. Mr. Frazier is also in charge of Anchor's research, new production development, and quality control programs. Before going to Anchor Concrete, he was connected with the Washington Brick Co., Washington, D. C.

Richard J. Frazier

Alvin R. Jacobson, associate professor and head of the division of sanitary science in Columbia University's School

(Continued on page 32)

the economy of size

A 14 ft. inside diameter, 16 ft. long section of subaqueous reinforced concrete pipe enroute to installation site via American's special-built 99 ft. truck and trailer. Weight per pipe section was reduced from an estimated 75 tons to 50 tons by use of lightweight concrete aggregates.

A new steam station at Huntington Beach, California is another project in the long-range program of the Southern California Edison Company which has been undertaken to provide needed kilowatts for Southern California's dynamic industrial and domestic growth.

In solving the problem of circulating 352,000 gallons of sea water per minute from a point approximately 2500 ft. out in the Pacific Ocean to the plant's condensers and back again, Edison's engineers called upon American Pipe and Construction Co. to help design and to manufacture the largest diameter precast reinforced concrete subaqueous pipe ever made. Each individual pipe section has an inside diameter of 14 ft.

American's ability to manufacture and handle these huge pipe made feasible the use of two parallel pipelines of this size rather than four lines of approximately 9 ft. diameter pipe otherwise needed to circulate the required volume of water. Here, indeed is economy of size.

Take advantage of American's 50 years of research and experience for your next project. Write or telephone for information.

our 50th year

CONCRETE PIPE FOR MAIN WATER SUPPLY LINES, STORM AND SANITARY SEWERS, SUBAQUEOUS LINES

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Mail address:
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4635 Firestone Blvd., South Gate, Calif. Phone LOrain 4-2511
District sales offices and plants:
Hayward and San Diego, Calif., Portland, Ore., Phoenix, Ariz.
District sales representatives:
Seattle and Spokane, Wash.

News of Engineers

(Continued from page 30)

of Public Health and Administrative Medicine, recently returned there after serving eight months with the Public Health Service during a sabbatical leave. Dr. Jacobson was working on a project for the training division at the Robert A. Taft Sanitary Engineering Center in Cincinnati, Ohio. His activities are primarily in the field of air pollution and radiological health.

Harrison H. Roberts, since 1956 manager of foreign operations for Intrusion-Prepakt, Inc., Cleveland, Ohio, has been promoted to vice-president of the company. Before joining Intrusion-Prepakt, Mr. Roberts was chief engineer for the Walsh Canadian Construction Co. working on an excavation contract for the St. Lawrence Seaway Authority. He has also been chief engineer on the Bull Shoals Dam, Detroit Dam, and Liberty Dam Projects.

Harrison Roberts

W. Lloyd Gallagher, project engineer for the San Francisco office of B. D. Bohna & Co., Inc., has been appointed manager of the firm's new Seattle office. Before joining the B. D. Bohna Company, Mr. Gallagher was connected with the General Electric Company in Richland, Wash., for nine years.

George W. Stamm has been appointed general manager of sales with the Crucible Steel Co. of America in Pittsburgh, Pa. Connected with Crucible Steel since 1940, Mr. Stamm has held various positions in Syracuse and Cleveland, and since 1954 has been assistant general sales manager in Pittsburgh.

J. Stephen Watkins, consulting engineer of Lexington, Ky., announces the opening of a new branch under the resident direction of **Maurice R. Hamill.** The firm's new offices will be at 107 Hale Street, Charleston, W. Va.

Richard L. Steiner, since 1954 deputy commissioner for the Urban Renewal Administration, Washington, D. C., is now commissioner of the administration. For eight years prior to his appointment with the URA Mr. Steiner was director of the Baltimore Redevelopment Commission.

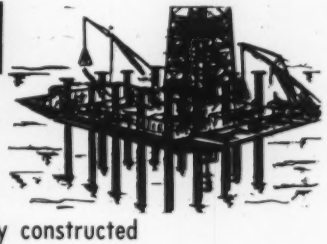
Herbert T. Jenkins, professor of civil engineering at Cornell University, has been appointed professor of engineering drawing and chairman of the department of engineering drawing at the University of Michigan. A graduate of the University of Michigan, professor Jenkins has been at Cornell for the past 22 years, most of this time as head of the civil engineering drawing department. He was also a member of the Ithaca consulting firm of Bogema, Gifft & Jenkins. After July 1, his new office address will be 412 West Engineering Building, Ann Arbor, Mich.

Herbert T. Jenkins

Irving Ernest Boberg, since 1945 chief engineer of the Chicago Bridge & Iron Company, Chicago, Ill., has been elected a vice-president. Mr. Boberg became connected with the company in 1924 and has served it in various capacities including assistant to the chief engineer.

POSEY PILING...

. . . fabricated for off-shore drilling in the Gulf of Mexico



40′ long, 30″ O.D., ½″ wall . . . this Posey Piling is soundly constructed to withstand the severe strains and stresses it will encounter in off-shore drilling in the Gulf of Mexico. Posey Iron specializes in Pipe and Piling, from 20″ O.D. and larger, fabricated from wrought iron, carbon steel, low and high alloy steel, and alloy clad steel. A half-century of experience, plus modern equipment and engineering facilities, make Posey Iron a recognized source for fabricated pipe and piling for every purpose. Call in Posey Iron on your next pipe or piling job. Information and quotations without obligation.

POSEY IRON WORKS, INC.

STEEL PLATE DIVISION LANCASTER, PENNSYLVANIA

New York Office: Graybar Building

TANKS • DIGESTERS • PRESSURE VESSELS • STACKS • DREDGE PIPE

Ellis L. Armstrong is leaving Uhl, Hall & Rich, consulting engineers of New York City to become director of the Utah State Road Commission, Salt Lake City, Utah. Mr. Armstrong has been serving as assistant project manager for the firm on the St. Lawrence Project. Mr. Armstrong's career includes twenty years with the U. S. Bureau of Reclamation working on the design and construction of dams.

Ellis L. Armstrong

Garner W. Miller, chief engineering assistant, Memphis (Tenn.) District of the Corps of Engineers, recently received a special cash award of $300 for "superior performance of assigned duties" and the highest civilian employee performance rating of the Department of Defense. Mr. Miller has been in the Memphis District in various engineering and executive capacities since 1930.

Anthony F. Haven, senior structural engineer for Smith, Hinchman, and Grylls Associates, Inc., Detroit, Mich., is opening civil and structural engineering offices at 206 South Main Street, Ann Arbor, Mich., under his own name. The new firm will be affiliated with Albert & Knowles, consulting engineers of the same address. They will specialize in buildings, bridges, and foundations.

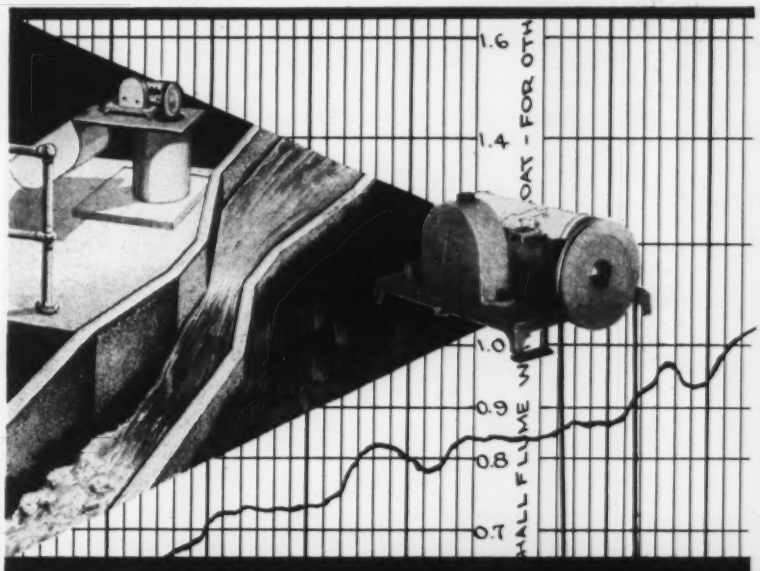
Two reassignments are announced by the U. S. Army Corps of Engineers. **Col. James U. Moorhead,** now with Army Forces in the Far East, will succeed **Col. W. W. Ragland** as assistant chief of engineers for real estate, with headquarters in Washington, D. C. Colonel Ragland, who has held his title since 1954, will be assigned to the U. S. Army in Europe.

Dames & Moore, soil mechanics engineers, have announced two changes in their Los Angeles office. **Charles L. Nichols,** former chief engineer, has been made an associate in the firm, and **Malcolm D. Horton,** who has been serving as staff engineer in the Los Angeles area, has been promoted to chief engineer.

Charles Nichols

Harry R. John recently opened the H. R. John Construction Co., Inc., with offices at 1112 East Broadway, Louisville, Ky. Earlier Mr. John was resident engineer for the Real Estate and Construction Department of the General Electric Company, Schenectady, N. Y.

NOW Low-Cost Automatic Flow Recording



STEVENS Type F Recorder

For Measuring Sewage, Industrial Waste and Other Flows

Flow charts directly readable in million gallons per day or gallons per minute over various sizes of Parshall flumes. The same recorder can also be used with charts reading in feet and hundredths to record head or surface fluctuations in lakes, streams and wells. Priced from $132. Write for free Bulletin 24.

The planning and efficient operation of any project which involves measurement of flowing liquids is based on flow data which can be obtained with STEVENS Water Level Recorders. STEVENS instruments are at work compiling data on hydroelectric and flood control projects and in water works, sewage disposal plants, irrigation and industrial installations in all parts of the world.

Experienced technical staff available for consultation on any liquid measurement installation. Write, giving description of project, and scope of data desired.

LEUPOLD & STEVENS INSTRUMENTS, INC.
4445 N. E. Glisan Street
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Specialists in Hydrologic Instruments for Half a Century

STEVENS DATA BOOK

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144 pages of technical data on recorder installations, plus a wealth of hydraulic tables and conversion tables. $1.00 each. (No COD's.)

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Please rush _____ copies of the STEVENS DATA BOOK for which I enclose $1.00 each.

Name _____

Address _____

whatever the problem . . .

Two things you're sure of when you use cast iron pipe. It will do the job. It will last.

Proved in *water* service . . . for fire protection, feeder and distribution mains, purification plants.

Proved in *gas* service . . . for feeder and distribution mains.

Proved in *sewerage* systems . . . for force mains, outfalls, treatment plants.

Engineers everywhere are familiar with cast iron pipe's outstanding record. They specify it because it's versatile . . . because its rugged strength has served for centuries. And, today, *modernized* cast iron pipe, centrifugally cast, is even stronger, more durable.

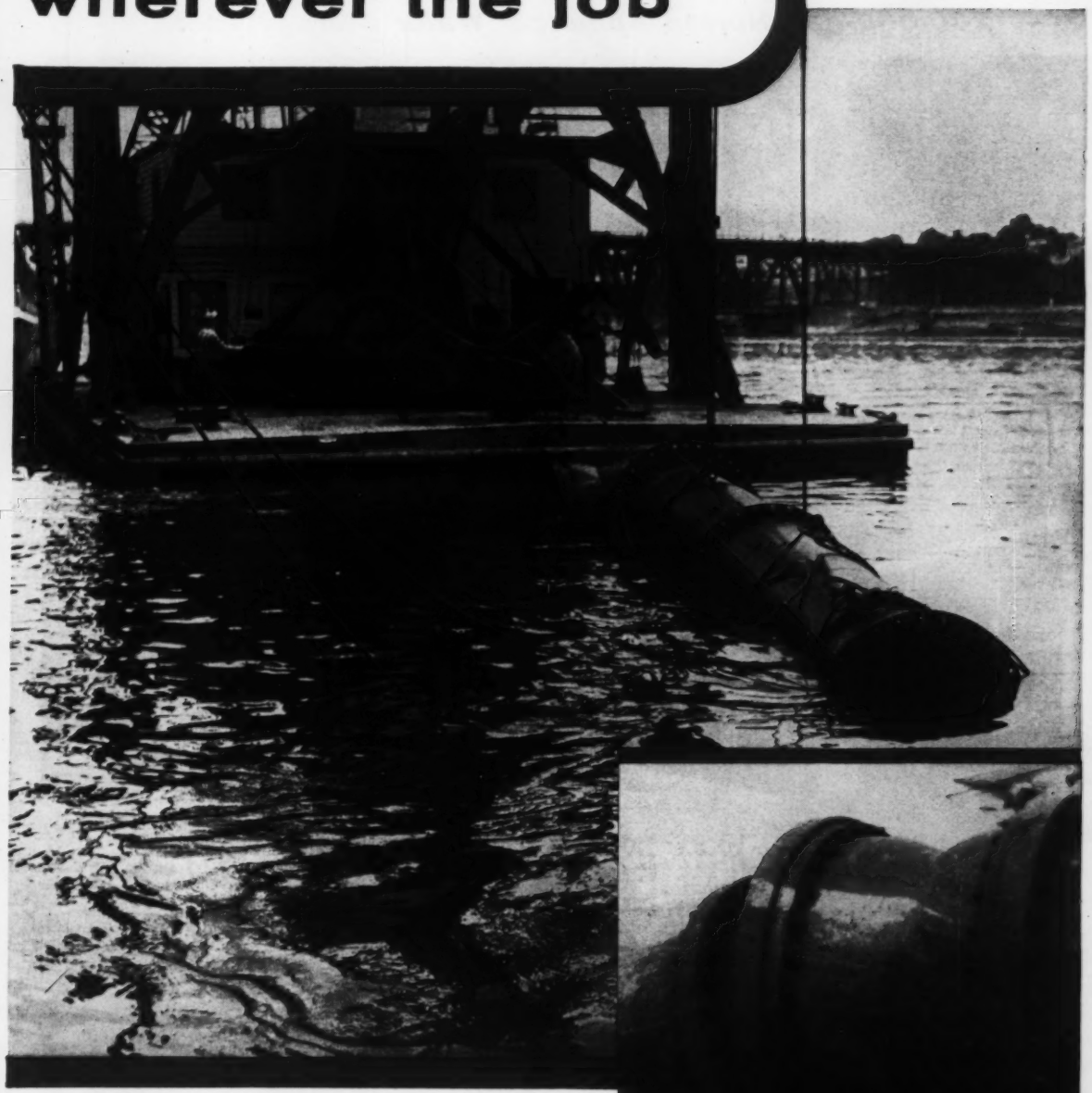
For information, write: Cast Iron Pipe Research Association, Thomas F. Wolfe, Managing Director, Suite 3440, Prudential Plaza, Chicago 1, Illinois.

Brooklyn, N. Y.—Laying 42" Mechanical Joint cast iron pipe for gas main.

CAST IRON

Cast Iron Pipe Research Association, Thos. F. Wolfe, Managing Director, Suite 3440, Prudential Plaza, Chicago 1, Ill.

wherever the job

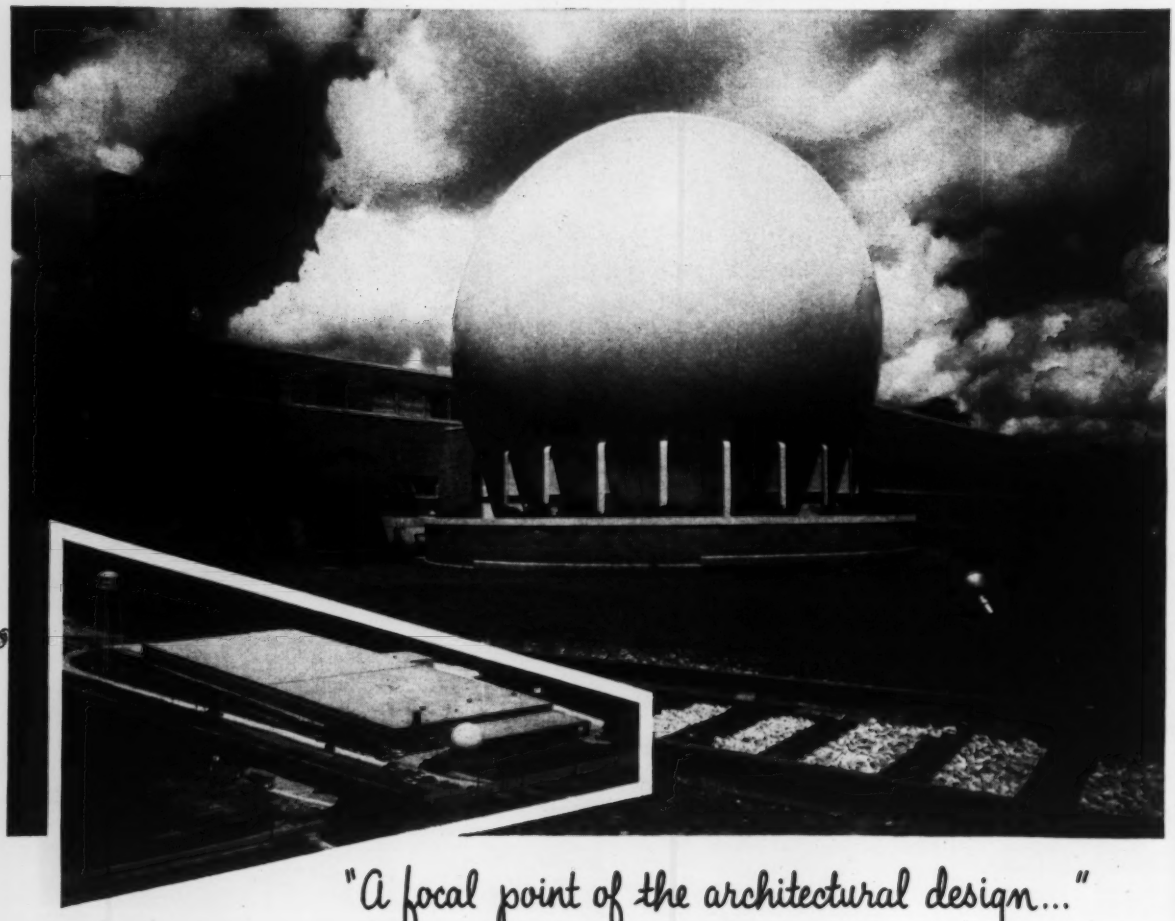


Portland, Ore.—Large diameter cast iron sewer lines being installed across Willamette River, part of program to restore normal river conditions for salmon spawning.

St. Louis County, Mo.—36" cast iron intake line at the North County Water Plant of the St. Louis County Water Company.

SERVICES FOR CONSULTING ...

200,000-gal. Horton Spherical Water Storage Tank



"A focal point of the architectural design..."

at Waxdale

• A 200,000-gal. Horton® spherical water storage tank, used to supply the plant sprinkler system, was chosen for Waxdale, Johnson Wax, Inc. Shipping Center at Sturtevant, Wisc. According to J. P. Halama, Johnson's Staff Architect, "We decided to make the reservoir a focal point of the architectural design and therefore, chose a sphere because of its aesthetic value." In addition, a 100,000-gal. Horton elevated tank was also installed to provide dependable *gravity* pressure water supply.

CB&I has complete facilities to design, fabricate and erect steel plate structures of standard or unique design. Write our nearest office for further information.

CBI

Chicago Bridge & Iron Company

Atlanta • Birmingham • Boston • Chicago • Cleveland • Detroit • Houston
New Orleans • New York • Philadelphia • Pittsburgh • Salt Lake City
San Francisco • Seattle • South Pasadena • Tulsa
Plants in BIRMINGHAM, CHICAGO, SALT LAKE CITY and GREENVILLE, PA.

are your pencils as sharp as your perspectives?
Efficiency reaches the vanishing point when you work with an inferior pencil—but hits a new high when you pick up an Eagle TURQUOISE. This is the pencil that tops 'em all for crisp drawings and reproductions, and these are the reasons: 1. It gives you uniform grading (17 scientific formulas guarantee exactly the blackness you want—from every pencil, every time!). 2. It takes a strong non-crumbling needle point that stays sharp for line after long line of unchanging width. 3. You get inimitable smoothness—thanks to Eagle's exclusive "Electronic" graphite. TURQUOISE makes your perspectives look sharp—and you, too!
WRITE FOR FREE SAMPLE Turquoise wood pencil and Cleantex Eraser, naming this magazine—or buy any of these drawing instruments from your favorite dealer.
2H
• TURQUOISE DRAWING PENCILS: With 100% "Electronic" graphite. 17 grades, 6B through 9H.
TURQUOISE
DRAWING
LEADS
• TURQUOISE CLEANTEX ERASER: Super-soft, non-abrasive rubber.
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• TURQUOISE LEAD HOLDERS: Hold any grade of Turquoise lead—so firmly that lead cannot be pressed back.
EAGLE TURQUOISE PENCILS, LEADS AND HOLDERS
are the largest-selling in the United States!
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"in the long run, we get MORE DOLLARS out of our MADSEN ASPHALT PLANTS"

Says . . .

R. C. (Bob) SULLY
Vice President
SULLY-MILLER
CONTRACTING CO.
LONG BEACH, CALIFORNIA

Engineering Data . . .

Concerning Sully-Miller's 6000-lb. Madsen Asphalt Plant shown.

- **PLANT MODEL . . .** Madsen Model 481 — 6000-lb. batch capacity.
- **SCREEN . . .** 48" x 16' Symons 2½ deck.
- **DRYER . . .** 96" x 30'.
- **BURNER . . .** 12" combination gas and oil.
- **DUST COLLECTOR . . .** 12' dia. cyclone and 65 tube multiclone.
- **WET SETTLING EQUIPMENT . . .** Madsen Triple Wet Tube Dust Washer-one 6' x 12' and two 6½' x 12' tubes.
- **TYPE OF FEED . . .** Tunnel to cold stone elevator.
- **PLANT SET UP INCLUDES . . .** dust elevator, dust bin and dust entering screw.

MADSEN WORKS LOS ANGELES — *Equipment that Serves*®

Sully-Miller Contracting Co. is one of the largest suppliers of asphalt and asphalt paving in Orange County and southern Los Angeles County. Like other leading producers of asphalt, the prime concern of this contractor is to get big-volume, money-making production day-in and day-out from his asphalt plants. That's why he's mighty glad to have the MADSEN Model 481 6000-lb. plant, shown above, on the job. It's one of several MADSEN Asphalt Plants owned by this successful operator.

The sturdy, oversize construction of MADSEN Plants means greater *sustained* production. With our new MADSEN 6000-lb. Plant, Bob Sully says *"we can turn out approximately 2000 tons per day of close specification mix."*

The MADSEN Model 481 Asphalt Plant offers many superior engineering features. For example: the exclusive MADSEN bin design (patent pending) which eliminates segregation . . . fast, accurate, all-air operation of bin gates, asphalt pressure injection and mixer gate . . . oversize capacity weigh-box, roller mounted so that it may be quickly rolled out of the way for easy field maintenance . . . the famous MADSEN Model 440 Twin-Shaft Pug Mill Mixer with improved mixing action . . . and the patented MADSEN Pressure Injection System.

Whether you are an established operator or a newcomer in the asphalt business — you'll want to get all the facts on the MADSEN Model 481 Asphalt Plant. This outstanding plant is available in 4000-lb., 5000-lb. and 6000-lb. batch capacities to meet your needs.

Ask your MADSEN Distributor for Catalog No. 800 or write MADSEN Works.
Baldwin-Lima-Hamilton Corporation P.O. Box 38, La Mirada, California.

THE MADSEN LINE OF PRODUCTS
FOR THE ASPHALT PAVING INDUSTRY
INCLUDES

ASPHALT PAVING PLANTS • PUG MILL MIXERS • AGGREGATE DRYERS • DUST COLLECTOR UNITS
ROAD PUG TRAVEL-MIX PLANTS • WEIGH BATCHERS • SUPER FLOAT AND JOHNSON FLOAT FINISHERS
ASPHALT TANKS • ROYAL CROWN PUMP VALVES • ASPHALT AND FUEL PUMP UNITS

BALDWIN BLH LIMA-HAMILTON

MADSEN WORKS
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CONSTRUCTION EQUIPMENT DIVISION
DIVISIONS: Austin-Western • Eddystone • Electronics & Instrumentation • Hamilton • Lima • Loewy-Hydropress • Madsen • Pelton • Standard Steel Works

. . . . . Am-Soc Briefs

▶ ▶ Seventy-five years ago. . . . In May 1882 the Annual Convention was being held in Washington. On the agenda were trips to inspect the status of work on the Washington Monument and on the city sewerage system . . . The Committee for Devising a Uniform System of Cement Tests complained that it "could not report understandingly . . . owing to the fact that very few members have responded to a call for sands from their several localities." . . . Members debated the desirability of holding a Convention at "some point in the extreme West." Minneapolis was the far site they had in mind.

▶ ▶ And today. . . . The Structural Division's Control Group for the Committee on Nuclear Structures and Materials has decided the time is ripe for forming four Subcommittees. . . . on Live Loads Due to Heat and Incident; Structural Aspects of Nuclear Insurance; Hot Laboratories; and Structural Materials in Reactor Design. David L. Narver, Jr., heads the Control Group. . . . Members working in the nuclear field are urged to submit papers for the 1958 Nuclear Congress, set for Chicago next March 17-21 (page 80). With abstracts due by July 15, prospective authors should get in touch with the Executive Secretary at once.

▶ ▶ Heading the new AASHO-ASCE Joint Cooperative Committee are Harmer E. Davis, professor of civil engineering at the University of California, co-chairman for ASCE, and Rex M. Whitton, chief engineer of the Missouri State Highway Commission, co-chairman for AASHO. Purpose of the new Joint Cooperative Committee, the Society's third, is to explore all means of pushing the new National Highway Program.

▶ ▶ ASCE Executive Committee doings. . . . The committee met at Walla Walla, on April 26 and 27, during the Pacific Northwest Conference to handle various matters requiring attention before the June meeting of the Board of Direction. Its actions are summarized on page 79.

▶ ▶ Orchids to our Sections. . . . The little Columbia Section (100 members) for its masterly hosting of the Pacific Northwest Conference at Walla Walla. . . . The large Los Angeles Section (2,546 members) for the outstanding success of its technical group program last year, and for having the largest number of dues-paying members (1,453) of any Section.

▶ ▶ At headquarters . . . Allen P. Richmond retired at the end of April after almost twenty-eight years on the Society staff — many of them in charge of Student Chapter work.

▶ ▶ Ever wish you could get more out of your vacation. This summer is the time. The District 7 Council will meet, July 19 and 20, at the North Central School of Agriculture, Grand Rapids, Minn. (not Mich.), center of a beautiful lake region. . . . Stimulating San Francisco will be host for the World Conference on Prestressed Concrete, July 29-August 2. . . . Then there is the Hydraulics Division Conference, set for August 26-28, in Cambridge, Mass., convenient to famed vacation lands.

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At right, Raymond boring rig in action on one of many special projects in Washington, D. C.

FOUNDATIONS FOR THE STRUCTURES OF AMERICA . . .

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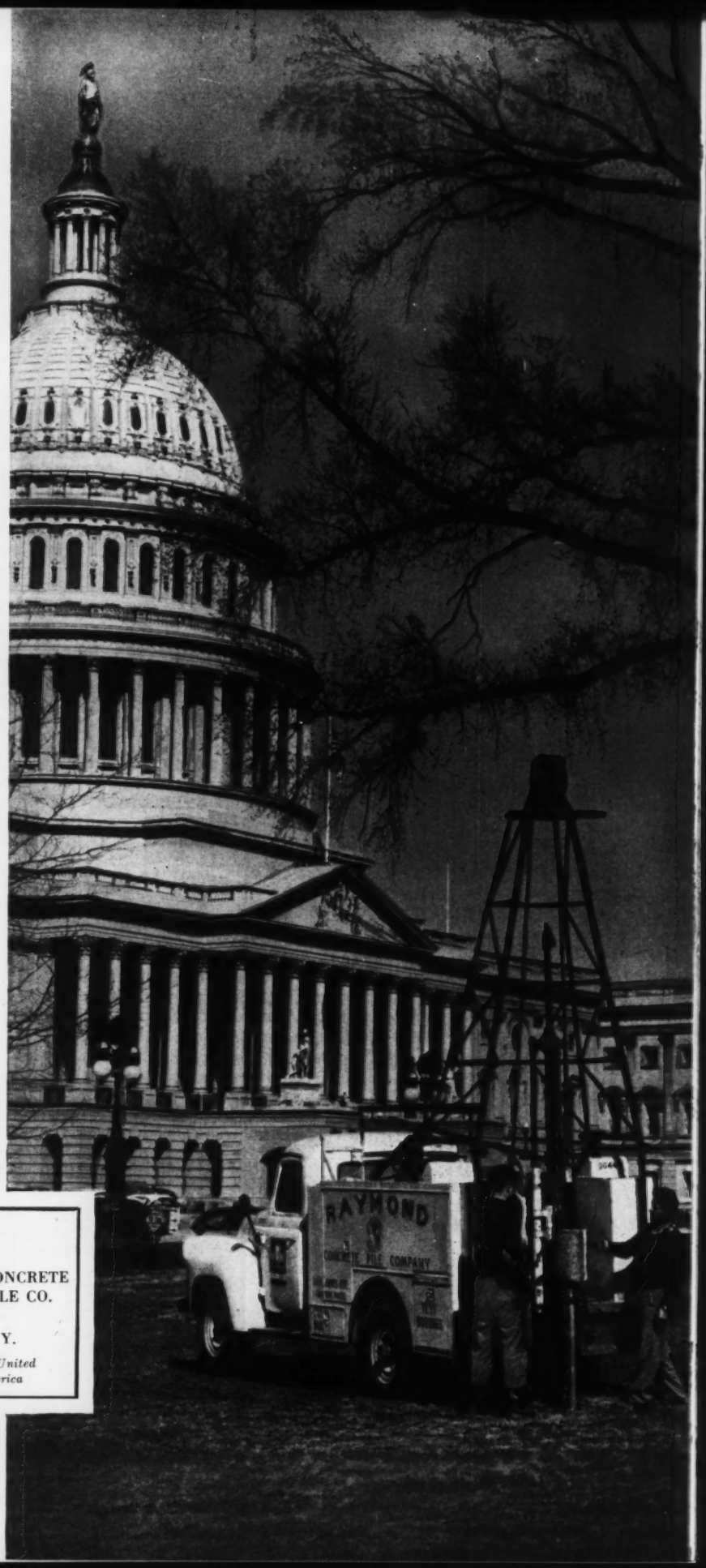

GOW DIVISION

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do you know that

Reflective thinking is one of the casualties of modern life? The engineering profession is especially hard put to it to find time for creative thinking in this day of rush and tension. This is one of the lines of thought developed by President Mason Lockwood in his stimulating annual address delivered at the Buffalo Convention and abstracted in this issue.

• • •

Sonic boom pressures are not sufficient to cause structural damage? U. S. Air Force findings indicate that, at its worst, the sonic boom exerts a pressure of 10 psf and that pressures in the neighborhood of 5 psf are more likely. For comparison, it reports that engineers and scientists studying the effects of shock waves generated by atomic explosions "have never observed damage to the flimsiest of structures at pressures less than 70 psf." The findings were made public at a Building Code Conference held at St. Louis University in April.

• • •

A 2,000-kw nuclear power plant can operate at full thermal load for a year and a half on a few pounds of uranium? This is one of the military advantages of the Army Package Power Reactor, which has just gone into operation at Fort Belvoir (page 96). Weight of the equivalent fuel in coal would be 18,000 tons.

• • •

There are five bridges across San Francisco Bay? Oldest of the spans serving the populous Bay area are the eight-mile San Francisco-Oakland Bay Bridge, opened to traffic in 1936, and the Golden Gate Bridge (with its 4,200-ft main span, still the longest in the world), opened in 1937. The newest is the recently opened Richmond-San Rafael Bridge—a four-mile over-water crossing with highway approaches in Marin and Contra Costa Counties. The other crossings, purchased by the state in 1951, are the San Mateo Bridge and the Dumbarton Bridge, which carries California Route 107 across the lower Bay. This roundup of Bay bridges is from the April issue of "Better Roads."

• • •

The oldest functioning civil engineering project on earth is in Turkey? This ancient structure is the Shamiram Aqueduct, which is in use after more than twenty-five centuries of service having been built in the Eighth Century B.C. Source of this information is the Arizona Section Newsletter (February issue).

• • •

Canada is starting its first modern toll road project? The 29-mile, six-lane highway, connecting Montreal with the Laurentian resort area, will be built by Quebec Province under recent authorization of the provincial Legislative Assembly. Cost of the project, which will include two bridges and 48 underpasses, is estimated at $40,000,000.

• • •

Concrete is being placed in the new $166 million Priest Rapids Dam? Late in April first concrete was poured for the huge new dam that will harness the Columbia at Priest Rapids, Wash. About 910,000 cu yd of concrete will go into the central section of the dam alone. With a capacity of 630,000 kw, the project will be one of the largest sources of hydroelectric power in the country. It is being built for the Public Utility District of Grant County by Merritt-Chapman & Scott Corporation under a $91,880,625 contract covering the dam and powerhouse.

• • •

The drought in the Southwest appears to be broken? Late-winter blizzards and recent spring rains have brought the first real relief to the dust bowl area in eight years. A case in point is long-parched Dallas, which reports that it now has more than five years' supply of water in storage. More than 14 in. of rain in April filled city reservoirs with 250 billion gallons of water. With the exception of West Texas, the moisture outlook is also good for the rest of the state. Encouraging news, too, from Kansas, Colorado, and Oklahoma. Eastern New Mexico and Arizona (where more rain has fallen this year than in all of 1956) report that shortages are still critical.

• • •

This is the centennial of the steel industry? In May the industry launched its celebration of the 100th anniversary of the mass production of steel in the United States with a Steel Centennial Exhibit in New York. In forthcoming months it will honor William Kelly and Sir Henry Bessemer (of England), whose discovery of the pneumatic steel-making process ushered in the Steel Age. There will be honors, also, for John Fritz, famous ironmaster and Honorary Member of ASCE, whose inventions included a new and more effective type of rolling mill. Present annual capacity of the industry is 133.4 million tons.

• • •

Over a million people have died in highway accidents since 1900. The toll of injured is at least 40 million. At the outset of a new motoring season the Center for Information on America has made available a timely guide to better highway practices, entitled "Highway Safety: Can We Learn to Save Lives"? Copies are available from the Center, which has its headquarters at Washington, Conn., for 25 cents apiece.

ATOMIC RACE-TRACK

Air view of Magnet Enclosure Tunnel shows site of subterranean Target Building, central foreground; Service Building at left.

$26-Million Machine Will Create Matter as Well as Smash it

ASSOCIATED UNIVERSITIES, INC.
BROOKHAVEN NATIONAL LABORATORY
Magnet Enclosure Tunnel, Upton, N. Y.

Designed by
STONE & WEBSTER ENGINEERING CORP., New York-Boston

General Contractor:
WHITE CONSTRUCTION CO., INC., New York City

Lone Star Ready-Mix Concrete:
SUFFOLK SAND & STONE CO., INC., Yaphank, L. I.

• A giant ring of magnets, housed in this half-mile-long, circular concrete tunnel, will speed protons to energies of 25-30 billion electron volts, in the world's most powerful atomic machine, transforming matter into energy and, conversely, creating matter out of energy.

Modern concreting know-how made it possible to build this 18-x-18.-ft., half-mile long, circular tunnel in less than three months. Ingenious form design was the key to smooth, rapid job progress.

Working around the circle on both sides, two sets of movable forms were used, each set forming 112 ft. at a time. After pouring the lower part of the tunnel, a travelling scaffold was used as a working platform to erect upper walls and roof. Forms were never lowered to ground during construction.

The Contractor averaged 225 ft. of tunnel a week, placing an average of 200 cu. yds. of concrete a day. This Lone Star Cement concrete averaged better than 5000 psi at 28 days, against a specified 3000 psi.

Noteworthy example of concreting know-how getting the utmost out of quality cement in first-class ready-mixed concrete . . . producing an outstanding structure, worthy of its role in one of the scientific wonders of the day.

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CIVIL ENGINEERING

MORE PHOTOGRAMMETRIC RESEARCH NEEDED

CHARLES L. MILLER, J.M. ASCE, Assistant Professor of Surveying and Director, Photogrammetry Laboratory, Massachusetts Institute of Technology, Cambridge, Mass.

Photogrammetry is one of the most dynamic fields contributing to the technological and professional advancement of civil engineering. Although photogrammetry already offers large savings in cost and time over conventional civil engineering methods of surveying and mapping, there is still a need for considerable research and development in this area.

One of the major advantages of photogrammetric surveying methods over ground methods is the reduction in manual effort. However, there are major manual steps in photogrammetry, including ground control surveys, stereo-compilation, and drafting. In each step skilled technical manpower is required. With the acute shortage of competent personnel, reduction of manual effort in photogrammetry offers one of the most fruitful areas for research.

To reduce the amount of manual ground control required, intense interest is now being exhibited in aerial photogrammetric triangulation, primarily for horizontal control but also for vertical control. New technological developments in electronic and optical instrumentation are also being applied by progressive firms.

The manual requirements of stereo-compilation are a real challenge to research. Although part of the function of the human stereoplotter is mechanical in nature, human judgment does play an important role. Applying automation in the complex interpretative role now filled by the human element offers problems of tremendous scope.

Research has been under way for some time on a completely automatic stereoplotting system, in which the human element is replaced by electronic systems. The difficulties experienced in this type of research often defy immediate solution but do indicate the breadth and scope of current photogrammetric investigations. An automation plotter for contouring and profiling has reached the prototype operational stage at the Hycon Manufacturing Co. plant under the sponsorship of the Engineer Research and Development Laboratories.

During the past decade the use of photogrammetery in the planning and location phase of civil engineering projects has become almost universal. The new emphasis in application is on the design phase. There is a rather conclusive trend toward the use of photogrammetry for all necessary surveys and maps used in the design of engineering works such as highways. The ability to produce a complete set of detailed highway construction plans, including final quantities, without conventional ground surveys has already been demonstrated. In a relatively few years the use of photogrammetry for design surveys and maps will be universal.

Several groups are working toward a solution of the problem of integrating photogrammetry with electronic computers. By such integration is meant the development of a continuous data-handling system which will procure the initial information from a photogrammetric model of the terrain, store it, and pass it to an electronic digital computer for analysis and reduction to desired earthwork quantities. The greatest potential value of such a system is the opportunity to evaluate many possible location and design solutions in a highly efficient manner.

The research staff at the Photogrammetry Laboratory of MIT's Department of Civil and Sanitary Engineering has been making investigations on such an ultimate data system for highway engineering. Although limited versions of a semi-automatic system are already in use by some highway engineering groups, considerable research must precede ultimate development, since the technical problems presented defy solution with our present knowledge and existing instrumentation. Recognition by state highway departments, private engineering firms, equipment manufacturers, and the civil engineering profession generally, of the technical and economic implications of semiautomatic data systems will expedite the attainment of the goal of realizing the full potential value of photogrammetry and computers.

A conservative estimate of the expenditures that will be made by state highway departments for photogrammetric and related services during the next ten years indicates a sum in the order of magnitude of 200 million dollars. It could be twice this amount. Because of the tremendous potential for technological advancement, an expenditure of as much as 5 percent of this amount for research and development in photogrammetry in association with computers and automation instrumentation is entirely reasonable. Therefore we should be thinking in terms of a collective research expenditure of $1,000,000 every year for the next decade. Although this sounds like a lot of money, it is only approximately one-thirtieth of one percent of federal highway expenditures alone.

Whether this amount of research is realized or not, we can expect to see major changes in civil engineering photogrammetry as a result of the national highway program.

(Prepared from the paper presented by Professor Miller at the ASCE Jackson Convention, before the joint session of the Highway and the Surveying and Mapping Division, presided over by Milton O. Schmidt, a member of the latter Division's Executive Committee.)

A. O. QUINN, A.M. ASCE

Chief Engineer, Aero Service Corporation, Philadelphia, Pa.

PHOTOGRAMMETRY for the highway

Demands for rapid, accurate methods for producing topographic maps, currently sparked by the huge national highway program, have resulted in the development of new techniques in surveying and mapping. Engineering specialists known as photogrammetric engineers have found economical solutions to many time-honored problems and cheaper ways to accomplish expensive surveying and mapping procedures.

Through the use of aerial photography, the photogrammetric engineer can: (1) provide high-altitude photos for route determination, (2) make preliminary geologic and soil studies, (3) locate highway materials, (4) study land use, (5) determine cross sections, and (6) prepare plans and profiles for use in highway design. This work is accomplished through the application of fundamental mathematical principles and the use of highly precise stereophotogrammetric instruments. It is done at a fraction of former costs for such operations and at a speed designed to meet the rush requirements for our much needed highway construction projects.

Not too long ago the highway engineer made his preliminary route location by walking the route under consideration for a new highway. This inevitably led him along streams and existing paths. A U.S. Geological Survey topographic map at a scale of 1 in. = 2 miles, and showing 50-ft contours, was helpful in making a preliminary location of the line. But as the engineer walked the route to make his final selection, the area covered was necessarily very small. It was always easy to miss desirable routes "on the other side of the mountain."

Now the photogrammetric engineer obtains high-altitude aerial photographs taken with a high-resolution, low-distortion lense on a distortion-free aerial film. These photographs provide a permanent record of a large area between known termini.

Photo interpretation specialists with a background in geology, pedology, forestry and geography, can provide the engineer with reconnaissance studies of geology, soils and land use. These data are obtained from a stereoscopic study of the photographs (scale, 1:40,000). In the same way many routes can be studied to ascertain the most economical and feasible one, and topography along each route can be investigated.

General requirements for bridges and culverts, together with investigations of rock excavation and property ownership problems, can be looked over in preliminary studies to determine the best route for further study and detailed mapping. During a recent investigation of this type in Alaska, the photo-geologist was able to accurately locate valuable gravel and aggregate materials required for the highway subbase. Ground reconnaissance over the same general area had failed to reveal the deposit.

In areas where U.S. Geological Survey topographic maps are up to date, the highway engineer can often lay out several routes for which he desires detailed maps for additional study. These detailed maps and the ground surveys needed to prepare them by photogrammetric methods play a vital role in the location of the future highway. Therefore great care should be exercised in establishing the requirements for surveys and maps.

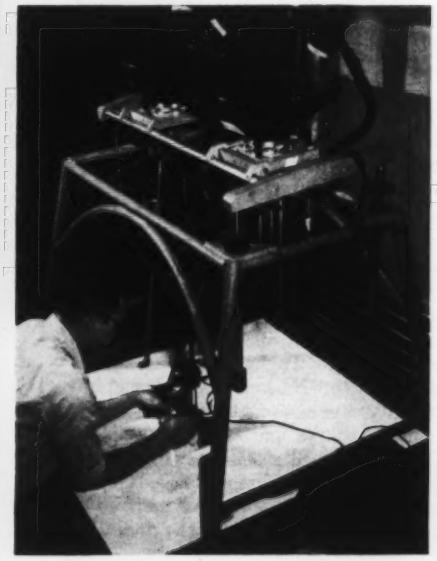
The selection of contour interval, map scale, location of permanently marked ground control, accuracy of traverse and bench levels, and map content should be determined with the assistance of competent photogrammetric engineers who can design the mapping program to fit the requirements of the highway engineer. Due regard must be given also to topography, location of existing survey monuments, weather, tree cover and vegetation, planimetric features, and accuracy requirements. Such considerations help in planning the mapping program so that proper photogrammetric techniques and equipment will achieve the desired results. Because of the many variables, so-called "standard specifications" can serve only as a reference guide. They must be altered to fit the particular circumstances of each job.

Most highway departments ask for maps at a scale of 1 in. = 200 ft, showing 5-ft contours for highway location. Photography for these maps is usually flown at an altitude of between 6,000 and 7,500 ft above the average ground elevation. To convert the wealth of information on the aerial photographs into a map, the photogrammetrist creates a spatial model of the terrain covered by two overlapping photographs in the stereoscopic mapping instruments.

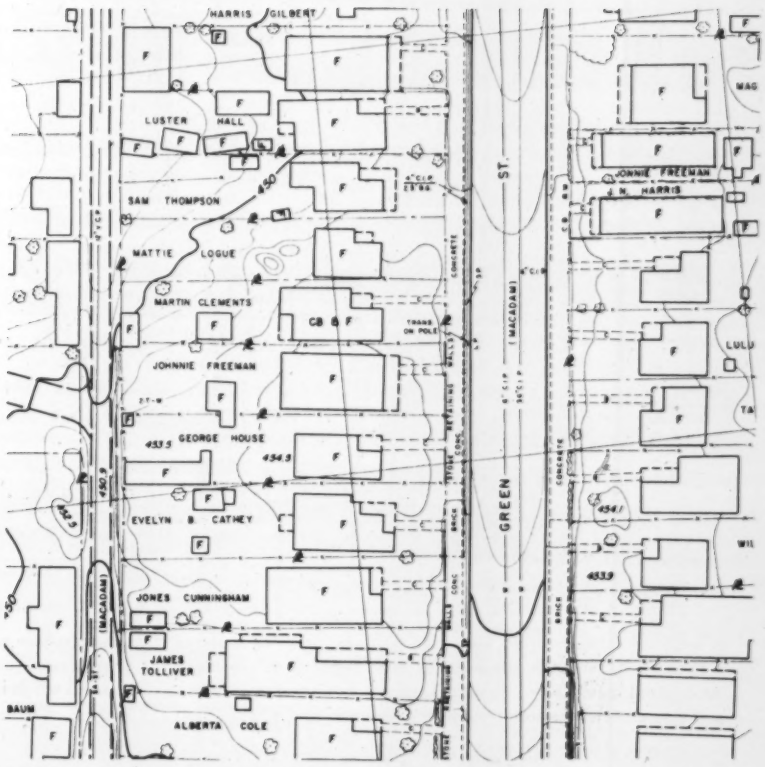
Geometric conditions existing at the exposure of the aerial photographs are reconstructed through the photo "control points," whose positions and elevations are established by ground survey methods. Stereoscopic mapping instruments such as the Kelsh Plotter, the Multiplex Aero Projector, the Balplex, the Wild A-8 and A-7, and the Zeiss Steroplanigraph are used. The stereoplotter operator sees the terrain in the third dimension, and by means of the plotter's measuring device he can determine differences in elevation. A drawing attachment records topographic and planimetric features at a predetermined map scale.

Topographic maps usually are designed to meet National Map Accuracy standards. For horizontal accuracy, the principal requirements are that 90 percent of all well-defined points tested shall be within 1/50 of an inch of their true positions on maps to be published

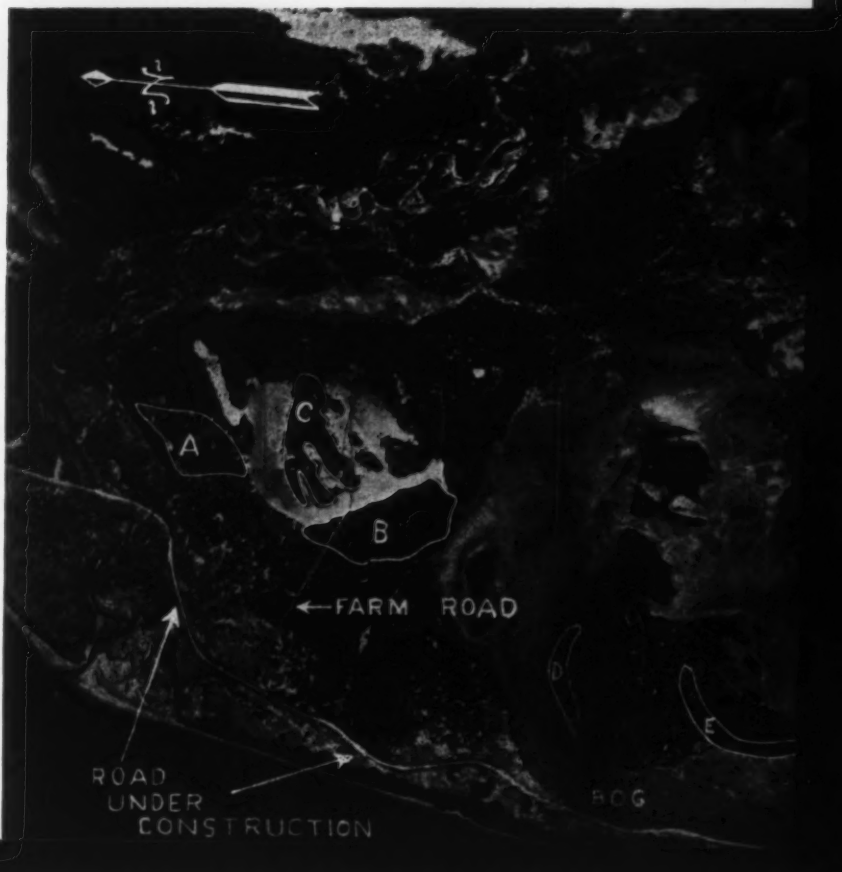
engineer



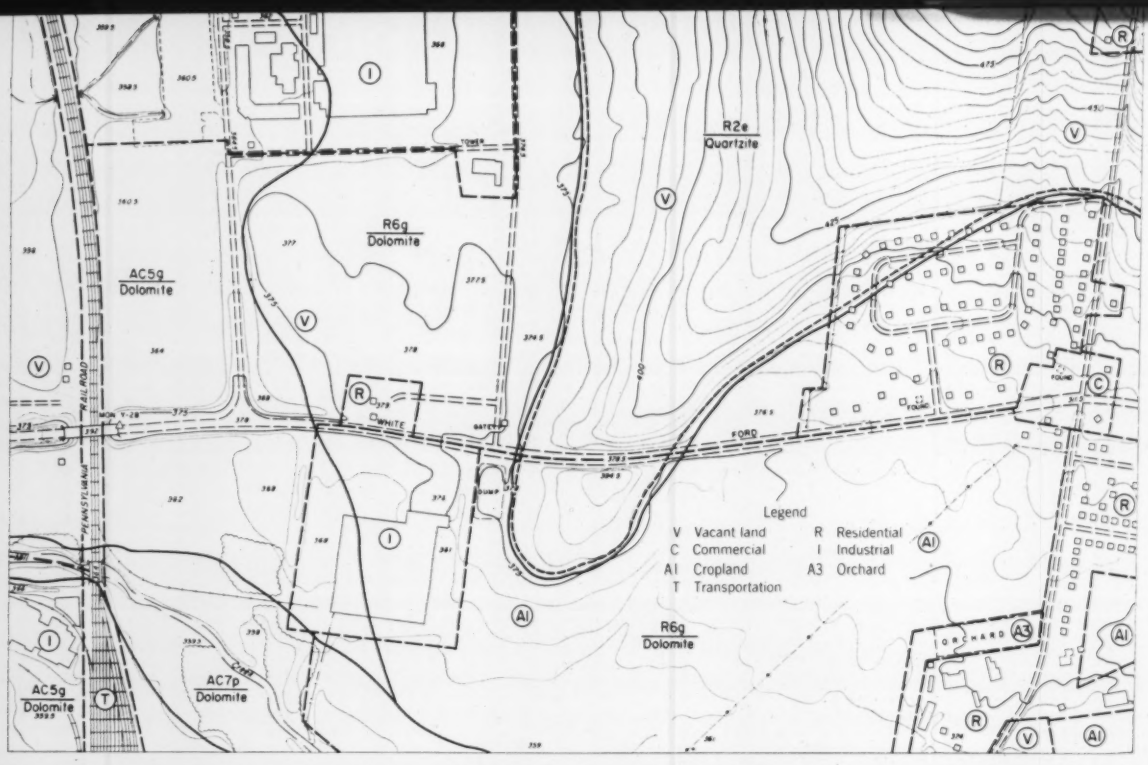
Kelsh stereoplotter is widely used in highway and other topographic mapping. American designed, it costs less than $10,000. Cover photo shows precise Swiss instrument, Wild A-8, employed in highway mapping, which costs nearly $30,000.



Section of detailed topographic map is typical of those used for final highway design in an urban area. Original map, here reduced one-half, showed this section of Nashville, Tenn., to scale of 1 in. = 40 ft, with 1-ft contours.



Aerial photographs tell geologist and soils specialist a great deal about borrow sites. This aerial photo, at scale of 1:40,000, shows road under construction in southern Alaska. Sites "A" and "B" are old stream terraces containing well-graded gravels and some coarse sand, under 2- to 3-ft overburden. Site "C" consists of old channel bars of sand. Existing farm road provides access to these three sites. Sites "D" and "E" are old sand bars, but intervening bog makes them practically inaccessible. These sites were located solely by aerial photography, and subsequent field check proved interpretation was accurate.



A section of engineering soils and geology map, to scale of 1 in.=200 ft, with 5-ft contours, is here reduced to one-third its original size. Heavy dashed lines are boundaries between soil types. Symbols follow Lueder's System, and explanation accompanies each job. Soils are mostly fine sand on hard gray-green quartzite. Depth to bedrock varies from 3 to 6 ft. These well-drained soils should be investigated for possible borrow. Excavation of bedrock will probably be difficult.

at scales of 1:20,000 or smaller, and within 1/30 of an inch for maps at publication scales larger than 1:20,000. The principal vertical accuracy requirements are that 90 percent of the contours or elevations of points interpolated from contours shall show the true elevation within half a contour interval.

In addition to the topographic information, the photo interpretation specialist is called upon to make detailed geological and soil investigations. He uses the lower-altitude photographs obtained for the mapping to outline geologic and soil types. This information is usually presented as a map overlay, with a report describing the soil types and the geologic conditions. Office studies are supplemented by field sampling and inspection.

With the soils information at hand, the designer's efforts can be concentrated on problem areas. In areas with similar soil types, borings can be made less frequently; only in transition zones will borings be needed at standard intervals. This of course reduces the time and cost required for the borings. At the same time, prospective sites for borrow and road material near the right-of-way can be located. Further studies of land use and property outlines can be made on the aerial photographs and shown on an overlay of the topographic map.

The topographic map, with overlays showing soils, geology, land use, and property information, forms the basis on which the design engineer can determine the most feasible route for the highway. From these data preliminary estimates of quantities for comparable routes can be prepared. The prepared centerline can be located on the maps and coordinates determined for the PC's, PT's, and PI's of the preliminary centerline. Using these data, the "P" line can be staked in the field, and critical points marked by panels for aerial identification. After location of the "P" line, the route can be rephotographed from an altitude of between 2,000 and 3,000 ft. From these photos a topographic map at a scale of 1 in. = 50 ft can be prepared showing 2-ft contours. This can be used to determine cross sections along the route.

When this low-altitude photography is obtained, additional photos should be taken at important bridge and culvert sites so that more detailed topographic maps can be compiled for these critical places. For such locations, 1-ft contour maps at scales as large as 1 in. = 20 ft can be prepared by photogrammetric methods. Similarly, in urban areas, very detailed topographic maps showing 1-ft or 2-ft contours can be prepared, and these can serve as a base for the plotting of underground utilities and detailed property-line locations. From the low-altitude photography, it is possible to map very accurately the locations of telegraph poles, hydrants, curbs, manholes, sewer outlets, and other critical features that may affect the location.

For design of the Inter-State Controlled Access Highway System within the City of Nashville and Davidson County, Tennessee, the consulting engineers, Clarke and Rapuano of New York, requested a two-phase surveying and mapping program. Phase 1 consisted of the preparation of maps at a scale of 1 in. = 100 ft showing 2-ft contours for undeveloped areas, and maps at a scale of 1 in. = 40 ft showing 1-ft contours for developed areas. In addition, they requested another set of maps at a scale of 1 in. = 100 ft to be prepared from the 1 in. = 40 ft sheets to provide a smaller-scale coverage of built-up areas and proposed interchanges. In rural areas, a width of 2,000 ft was mapped. In urban areas, the width was reduced to 400 ft.

The initial maps showed all physical topography, major subsurface construction, property lines (without metes and bounds) of highways, railroads, schools, cemeteries, parks and public buildings, size and type of culverts, major sanitary sewers, storm sewers, transmission lines, bridges and other structures, wooded areas, ponds, lakes, streams, pavements, and curbs. These maps were prepared by photogrammetric methods supplemented by ground surveys (in which traverse monuments and bench marks were set at 500-ft intervals near the proposed centerline)

and by field edit to delineate on the photographs the detailed information requested by the design engineers.

Following the completion of Phase 1, the engineers designated, on the 1 in. = 100 ft maps, an area about 300 ft wide along the revised centerline and at the various interchanges. Phase 2 of the job consisted of adding all property lines, coordinating street and right-of-way lines at bridge sites and railroad crossings, obtaining invert elevations for manholes and catch basins, locating all underground utilities, determining the elevations of critical bridge clearances, and establishing elevations for first floors of buildings and cellar bottoms. These data were determined by field survey and edit methods with the aid of the low-altitude aerial photographs and the maps prepared in Phase 1.

This work provided the consulting engineers with a complete set of maps and photographs, giving them all the basic data necessary for the design of the highway.

An important phase of the highway engineer's job is the public hearings required to discuss the location of the route. Since laymen attending these meetings are not familiar with topographic maps, relief maps showing the location of the proposed route are most effective in presenting the data to the public, particularly when the contours are superimposed on a photograph and the photograph is molded to show the third (relief) dimension.

Enlargements of the mapping photographs can be used effectively for public presentation. Enlargements to ten times the scale of the original are practical. Low-altitude oblique photographs taken along the proposed right-of-way and in critical areas give a detailed and easily understood impression of the highway problems. Controlled photo mosaics at a scale of about 1 in. = 500 ft, on which the highway routes and problems have been indicated, are most effective. (Mosaics are a compilation of many photos corrected for tilt of camera difference in elevation and the like.) Thus the highway engineer is provided with a graphic means of showing the details affecting the selection of the route, which simplifies land acquisition and other highway problems.

Cost and time required to obtain cross sections and ground profiles along the proposed centerline can be reduced. From low-level photographs reoriented in the stereoscopic mapping instruments, experienced operators can obtain cross-section information photogrammetrically. Recent aerial surveys for the Illinois Highway Department provided for the preparation of manuscript maps at a scale of 1 in. = 80 ft, showing 2-ft contours. Autopositive copies of these maps were used by the design engineers to make a location of the highway centerline. Using the photographs from which the map manuscripts were prepared, cross sections (approximately 75 per mile) were taken photogrammetrically.

Recent comparisons of volume computations made between field cross-sections and those obtained photogrammetrically indicate an average difference of between 1 and 3 percent. Using the low-altitude photography at a scale of 1 in. = 400 ft, the photogrammetric elevations determined along the cross sections can be read to an accuracy of 0.2 ft, and these cross sections can be determined with great speed. A stereo operator can take about 50 cross sections a day. The cross-section data can be punched on cards or on magnetic tape and fed to the newly developed electronic computers so that earthwork volumes, slope-stake coordinates for the use of field crews, and even mass diagrams can be computed automatically and printed on tabular sheets. With the assistance of electronic engineers, the photogrammetrist is designing auxiliary instruments to be used with photogrammetric plotting equipment. These will facilitate the transmission of basic-map and cross-section data to the electronic computers.

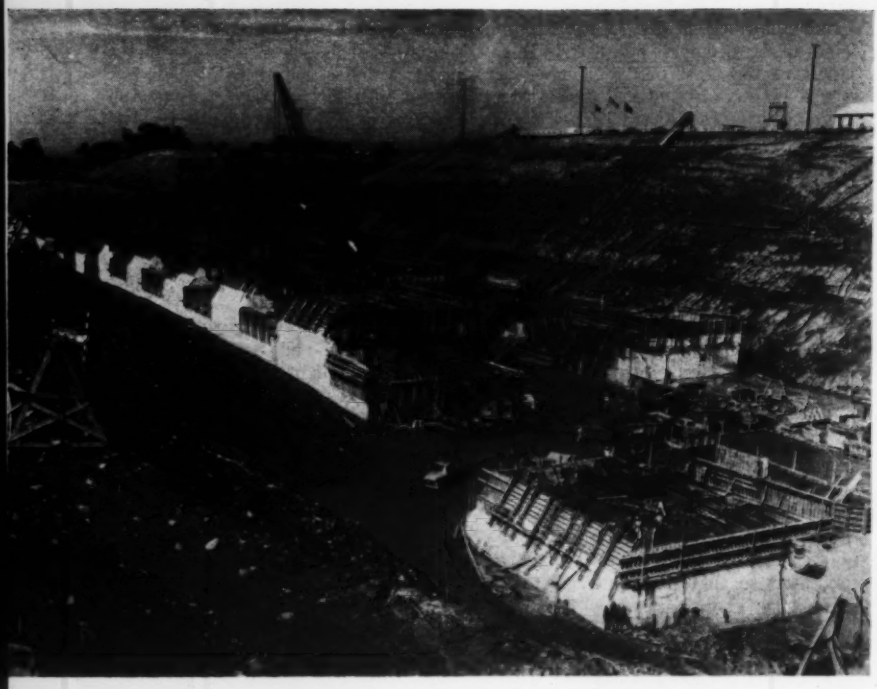
Many highway departments are proposing that the contractor be paid on the basis of quantities determined by photogrammetric methods without extensive use of engineering manpower to determine these quantities by the usual ground survey methods. This can be accomplished to the accuracy required by the contractors. To determine the final quantities at the completion of the highway construction, the area is photographed again at the altitude used for preparation of the original cross-section data. These photographs are reoriented in the stereoscopic mapping instruments, employing the same ground control used for the determination of the original cross-section values, and final quantities computed.

Nearly all state highway departments have used photogrammetric methods for one or more of their mapping projects. Properly designed and executed photogrammetric surveys and allied professional photo interpretation services can provide the highway design engineer with far more basic information than is available from ground surveys. The well-staffed photogrammetric engineering office provides a complete package of professional engineering services and products to fill the requirements for basic highway surveys and maps at a cost of one-third to one-half that of field surveys.

Photogrammetry is a relatively new application of fundamental mathematical and engineering principles, and the photogrammetric engineer is not content with the services and products he can at present deliver. Continuous research is being carried out in the application of these principles to problems of instrumentation, equipment, and mapping techniques to enable the photogrammetrist to solve a wider range of engineering problems with even greater speed and efficiency.

Services the photogrammetric engineer can render

- Consultation or planning for surveys and maps
- Aerial photography:
  - High-altitude, for reconnaissance
  - Low-altitude, for detailed mapping, cross sectioning, and profiles
  - Obliques, for public information and progress records
- Mapping to large or small scale
- Studies of soils and geological formations
- Field surveys:
  - To establish positions and bench marks
  - To locate underground facilities
  - To locate highway centerline for construction
- Property surveys:
  - For preliminary location of property lines and individual holdings (to be completed by authorized surveyors)
- Cross sections and profiles:
  - Measurement and computation of quantities (original, partial payment, and final)
- Relief maps and photo mosaics:
  - Enlargements or special displays for public presentation
- Design and detailing for highways
  - To be prepared by outside consultants as desired



Concreting of Dwight D. Eisenhower Lock was started July 11, 1956. Construction view shows about one-fifth of total of 500,000 cu yd of concrete in place. As of April 15, 1957, there were 265,000 cu yd of concrete in place. Date of completion for concrete placing is September 1, 1957. Note public observation area at top of bank in background. Photo courtesy of Buffalo District, Corps of Engineers.

Vertical-lift gate guards Long Sault Canal

STANLEY B. HUNT

Chief of the Engineering Division

Buffalo District

Corps of Engineers, U. S. Army

Buffalo, N. Y.

A vertical-lift gate that can be closed against a 46-ft depth of flowing water will guard the Long Sault Canal on the St. Lawrence Waterway. Constructed as part of the Eisenhower Lock, the extra gate will be used to stop water flow if the operating gates are damaged by a ship ramming them. Making the emergency gate a part of the lock rather than building a separate guard structure some distance upstream, as planned prior to 1942, permitted a $6,000,000 saving in the project cost. (See "St. Lawrence Seaway and Power Projects Started," by Emerson C. Itschner, M. ASCE, in CIVIL ENGINEERING for November 1954, and "St. Lawrence Power Project under Construction," by George R. Rich, M. ASCE, in the November 1955 issue.) The gate is shown in Figs. 1 and 2, and seal details in Fig. 3.

The Eisenhower Lock and the Grass River Lock on the Long Sault Canal, together will raise and lower ships 90 ft as they pass around the Barnhart Island Powerhouse, where generating equipment for 1,824,000 kw will be in-

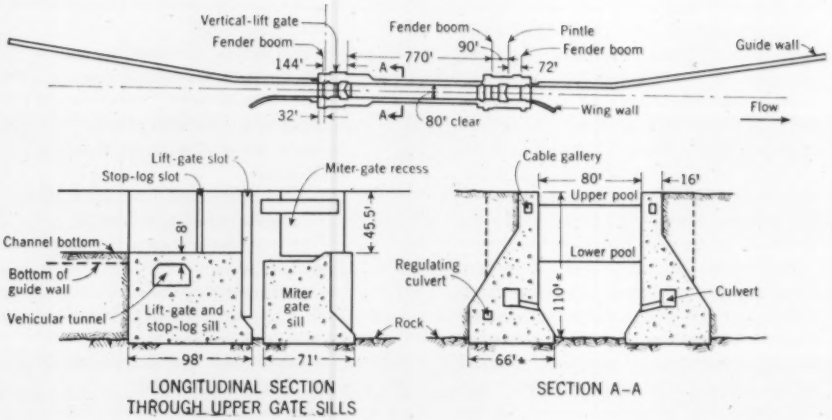


FIG. 1. Dwight D. Eisenhower Lock on St. Lawrence Waterway has length of 770 ft and width of 80 ft.

stalled. Failure of gates of the upper lock (most likely to be caused by an outbound ship ramming the gates) might result in draining of the important power pool. Also it would flood and seriously damage areas around the intermediate pool between the locks. The only means of discharge from the lower lock is through the culverts, which are completely inadequate to handle the flow through an open lock.

The vertical-lift gate is for emergency use only. Miter gates are being installed for regular ship passage. But the miter gates cannot be safely closed against a head of flowing water so another closure means is necessary. Placing of stop-logs or similar devices could not be done rapidly enough to be of value in an emergency.

The vertical-lift gate can be installed here without added excavation as rock, on which the upper gate sill is founded, is about at the elevation of the lower channel. The gate is 83 ft long to span a lock width of 80 ft. It is designed to resist a 46-ft head. Horizontal girders, which have a maximum thickness of 10 ft, have a skin plate on the upstream side. Closing speed of the gate is 2 ft per min. Study showed that little increased damage would result from this relatively slow speed in closing the gate if mobilization for action in an emergency required not more than 10 min. But operation is automatic by pushbutton, and so normally gate closure can start at once.

The gate weighs 700,000 lb, but for the design of operating equipment, this weight was taken as 800,000 lb to allow for the dynamic load of water that might be on the girders. The design load included 236,000 lb for vertical water force at the start of gate raising, 18,400 lb for side-seal friction, and 16,400 lb for roller friction. Total design operation load is 1,070,800 lb.

Forces acting on the gate were computed analytically and checked by tests on a model built to an undistorted scale of 1:33, a 50-ft width of gate being reproduced. Testing was done at the St. Anthony Falls Hydraulic Laboratory, operated by the St. Paul (Minn.) District of the Corps of Engineers. The model verified information as to vertical loads on individual girders, loads exerted on the gate during raising and lowering, and similar data.

Identical hydraulic cylinders at each side of the lock raise the gate, or control its lowering, through a cable arrangement. These cylinders are 44½ in. in diameter, 28 ft long, and operate at 1,500 psi. Separate pumps provide oil at 77 gpm to power the cylinders. Although the cylinders on opposite sides of the lock chamber are physically independent, an electrical skew control device keeps the gate level so that it does not bind in operation.

To operate the gate, the pump motors are brought up to speed without load by operating the pumps at full stroke with a dump valve open so that oil is returned to the reservoir under negligible pressure. When the motors are up to speed, the dump valves are closed and the oil is pumped at full capacity under a pressure of 1,500 psi into the rod end of the cylinders, thereby raising the gate. When the gate is 6 in. from the fully raised position, a limit switch changes the pump delivery to low rate.

When the piston reaches the stop, the pump continues to deliver oil and raises the pressure sufficiently to open a relief valve set slightly above the normal operating pressure. This will make up for leakage and hold the gate in the raised position. Simultaneously, hydraulically operated dogs are extended into locking position. When all dogs are in place, completing the circuit through individual limit switches wired in series, the pumps are shut off. The lowering cycle is a reversal of this sequence of operations. Operation is started by remote manual pushbutton. The sequence is fully automatic, with a manual "stop" button available for control. The gate will be operated frequently to be certain it is operable and to keep personnel familiar with its operation.

The vertical emergency gate will be a dependable installation. It lacks only physical separation from the lock to make it at least equal in effectiveness to the distant guard gate proposed prior to 1942. This was to be a miter gate structure normally left closed while either gate in the lock was open. An 80-ft width was planned, which would have slowed shipping.

A later plan (1942) contemplated sector gates, which would normally be open. But to avoid slowing shipping, a minimum width of 110 ft would have been needed. Either of these plans would have required essentially the upper sill of a lock with guide walls up and downstream. In addition, protective walls or dikes would have been required. These items account for much of the $6,000,000 saving.

The vertical-lift gate itself is more expensive than miter gates but in an emergency it can serve as the operating gate as well as to stop flow.

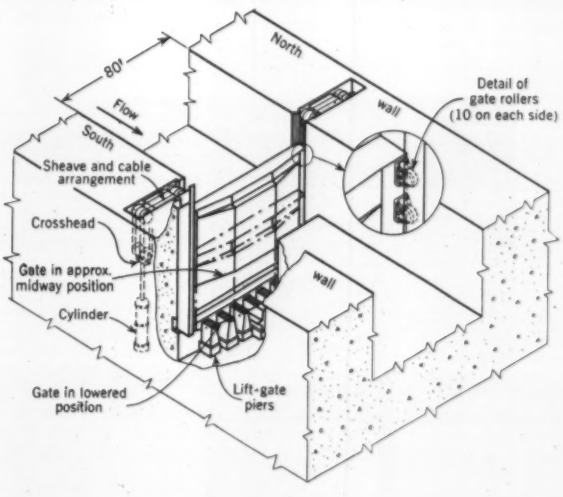


FIG. 2. Cutaway sketch shows vertical-lift gate installed at upper end of Eisenhower Lock to guard against gate failure.

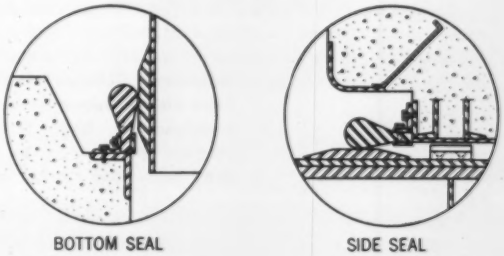


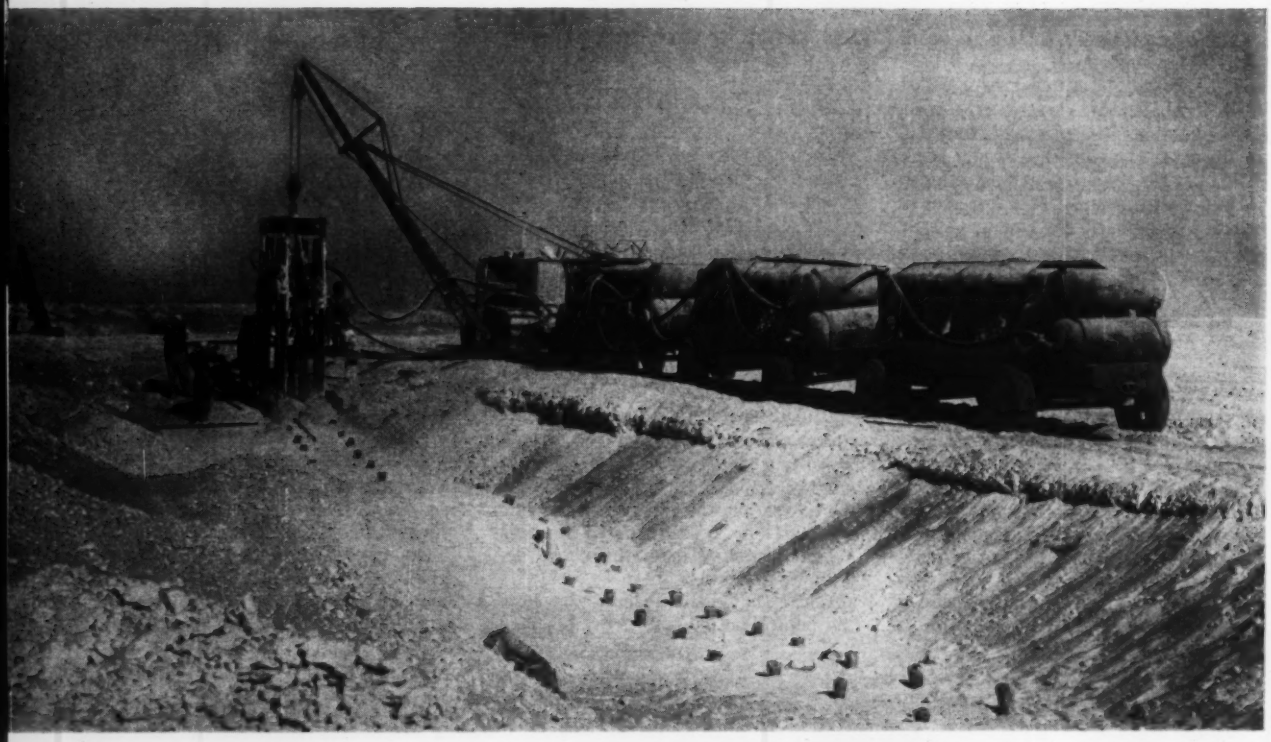
FIG. 3. Specially designed rubber seals close sides and bottom of vertical-lift gate.

GEORGE D. HARTLEY, A. M. ASCE

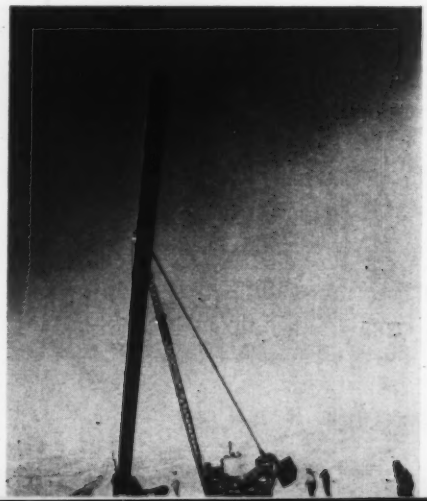
Construction Engineer, Arabian American Oil Company,

Dhahran, Saudi Arabia

PIPELINERS SPAN THE DESERT



Quad drill frame is suspended from sideboom for drilling where hard rock has been encountered. Sideboom tows compressors required for drill operation.



Sideboom "shakes out" 78-ft triple-ended pipe—that is, section prefabricated from three mill lengths. Purpose is to remove sand and other foreign material.

Petroleum fields of the Middle East are of growing importance in international trade because of their steadily increasing yield. Conflict and turmoil in the Middle East, with resulting closure of the Suez Canal, has focused attention on the importance of Middle Eastern oil on world markets and its strategic position in the race for power and conquest among nations.

Primary transport of petroleum products may be by pipeline or tanker or on occasion by a combination of both. Final selection of the transport medium has always been adjusted in line with the political conditions to be expected in an area where diverging economic and political interests may erupt into violence at any time. Closing of the Suez Canal, for instance, appears to encourage additional pipeline construction, but civil strife in any country through which the pipeline runs would favor shipments by tanker, as pipelines are vulnerable military targets.

News reports indicate that the Arabian American Oil Company has the largest investment of U. S. private capital outside the United States. Aramco is owned jointly by Standard Oil Company of California, 30 percent; Texas Company, 30 percent; Standard Oil Company, New Jersey, 30 percent; and Socony-Mobile Oil Company, 10 percent. During the year 1955, Aramco produced a total of 352,239,912 barrels of crude oil, which represented approximately 7 percent of the free world's oil supply.

The Trans-Arabian pipeline (Tapline) carries oil from the wells in Saudi Arabia 1200 miles to Sidon in Lebanon, where it is stored for transshipment by tanker. For the year 1955 shipments to Sidon totaled 117,988,503 bbl. Shipments are also made by underwater pipeline to Bahrain Island in the Persian Gulf, to the refinery operated by British interests there. Total products delivered to Bahrain during 1955 amounted to 63,150,219 bbl. The remainder of the 1955 production, 170,808,744 bbl, was delivered by pipeline to a tank farm at Ras Tanura in Saudi Arabia. This oil is available for tanker loading in the Persian Gulf or may be refined at the Ras Tanura refinery. Refined products are distributed to bulk plants in Saudi Arabia or to the Ras Tanura piers for tanker loading.

A study of statistics indicates that approximately 50 percent of Aramco's crude shipments are direct pipeline shipments to either Sidon, Lebanon, or Bahrain Island. The remaining 50 percent is transported by pipeline to Ras Tanura for tanker loading or to the refinery. Included in this 50 percent are company used products and refined products distributed to bulk plants in Saudi Arabia. Remaining refined products are available for tanker loading.

Aramco occupies an important position as a major supplier of world markets. Extensive exploration and drilling programs now in progress will further increase its stature. It is significant that its annual gross production of crude oil in 1945 was 21,310,996 bbl, whereas ten years later, in 1955, the total was 352,239,912 bbl. Production has increased 27 percent in the past five years. The full future potential is unknown. The fabulous Ghawar field now in production may contain the world's largest known oil pool.

Supplementing the vast spider web of pipelines and flowlines which traverse the desert will be a system of underwater flow and gathering lines in the Persian Gulf. These collecting lines will transport oil from off-shore wells to gas-oil separators on the mainland. Wells have already been drilled and platforms installed, and construction of the underwater portion of the line is timed to coincide with the completion of the 20-in. Safaniyah-Ras Tanura trunk line, also under construction at the present time.

Construction of the underwater portion of the line is facilitated by use of a 250-ton pile-driving and pipe-laying barge, designed by Aramco and built in England. Underwater parts of the lines will consist of 12 miles of 16-in. pipe, connected to 10 miles of 6-in. gathering lines. Pipe is delivered to the barge, where it is welded together in a continuous line. All welds are examined for flaws by trained technicians using X-ray equipment. After each section has been tested, the pipe is cleaned, primed, doped and wrapped. Final physical protection consists of a cement coating reinforced with wire-mesh reinforcing. When all operations are completed, the barge is moved forward, depositing the completed pipeline on the Gulf bottom. All underwater pipelines also have cathodic protection.

Pipeline construction is performed by Arab contractors, supervision being furnished by Aramco through its construction engineers or under a foreign contract. The extent of the supervision provided varies and in general is directly related to the degree of complexity of the work. Increasing reliance is being placed on Arab contractors, many of whom have previously been employed by the company and have developed skills through company training programs. In the early years of development, Arab contractors had considerable difficulty in recruiting adequate skilled manpower. Conditions are improving although to the Americans they may appear to be doing so slowly. But considering that the technical development of the country is of recent origin and that the principal form of locomotion for a large part

Backhoe strips rock on line extension work.

This 30-in. line is ready for final testing by hydrostatic pressure, generally applied to lengths of about 3,500 ft. First testing procedure is visual inspection of welds, followed by air-soap test, and by radiographic inspection of about 10 percent of all welds.

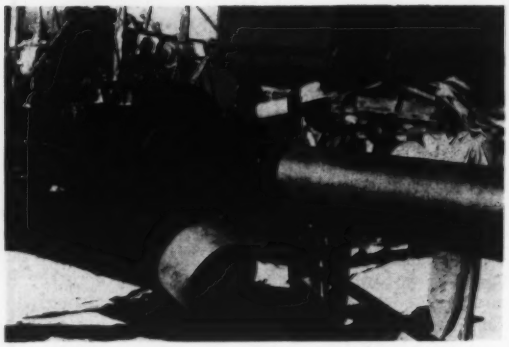
of the population is still by camel, progress is remarkable.

Large construction programs which include specialized skills are performed under the direction of a foreign contractor who also furnishes skilled craftsmen where Arab craftsmen have not developed the required skills. The foreign contractor is obligated to supervise and train the Arab contractor's personnel in the development of new skills. Company-sponsored training programs and certification of craftsmen, such as pipeline welders, has provided the contractors with a valuable source of skilled manpower at an increasing rate. Progress in the development of the Arab contractors to a professional status is making great strides, and under the guidance of the Arab Industrial Development Department, AIDD, can maintain adequate financial stability.

A few contractors with foresight are developing to the point where contracts have been awarded and construction performed without foreign contract personnel. This is a desirable trend. One Arab contractor, who has associated with him a former employee of Bechtel International, is constructing practically all the flowlines in the Ghawar field with a minimum of supervision. All pipeline construction is performed by the Aramco construction department under the direction of a construction engineer. Where foreign contract supervisory employees are eliminated, the construction engineer is responsible for the detailed physical construction of the project.

In general all major construction projects are built under the supervision of a foreign contractor. Bechtel International, IBBI, is the primary foreign contractor performing work in Saudi Arabia at present. Direction of the foreign contractor's work is also assigned to an Aramco construction engineer, who is responsible for job progress and quality of work.

Primary markets for Middle East oil are in countries where the medium of exchange is a soft currency. To maintain favorable dollar reserves, a mutual purchasing system permits maximum expenditures in these soft currency countries. Whenever possible, materials, equipment, tools and foodstuffs are purchased from them through the Aramco Overseas Company, AOC, established by Aramco at the Hague. Major responsibility of AOC is the preparation of designs and details for all new construction to be undertaken in the field, and the purchase of required materials from all countries in the world except the U. S. A., where purchasing is handled by Aramco.



Machine applies petrolastic primer to pipe and wraps it with glass cloth. Protection of buried pipelines against corrosive and abrasive forces is important since desert soils are highly corrosive, and have high salt content. Cathodic protection is also provided.

Since pipe for pipeline construction may be obtained from any country in the world, its physical and chemical characteristics vary. Despite rigid specifications and inspection requirements, these variations may escape normal testing procedures, and some latitude may exist in the specification itself. For example, it is rare that pipe from any U. S. mill will have anywhere near the full plus or minus 12½ percent variation in wall thickness permitted under the specifications. In Europe, this is not the case. The pipe thickness sometimes does vary this much and while it meets the standards, it is certainly much more difficult to fit up and weld than the more uniform U. S. pipe.

Similarly on API 5 LX 52 expanded pipe, the pipe we buy from England has tapered ends from the hydraulic expanding jig. The actual variation in diameter falls well within API tolerances, but it is very difficult to work with this pipe in the field. U. S. mills have improved expanding facilities which do not create this problem. Pipe most recently purchased from a German mill has the ends cut back to eliminate this trouble.

The higher percentage of scrap utilized in European mills produces a wider variation in chemical composition and introduces minor impurities, which render welding difficult. To improve this situation, more restrictive specifications are being written, particularly with regard to inspection. In recent years pipe has been in short supply and some relaxation in requirements has been necessary to maintain construction schedules. It would not be unusual to find in a single flowline pipe that came from two or three different countries.

Inspection and testing may be performed by AOC or by specialists hired by it. This inspection applies primarily to materials and equipment at the time of purchase. Construction inspection in the field is completely divorced from the construction department to preclude bias. Field inspectors test all welders periodically and certify them according to the type of work for which they are qualified.

Construction procedures in general follow established methods used in the United States. Once the need for a new facility has been established, detailed preliminary planning and economic studies are made to justify the project. Construction is authorized as soon as the budget expenditure is approved by the board of directors.

Aerial surveys are the basic source of information for preliminary design and selection of the proposed pipeline route. Selection of the final route is given more careful consideration. In a recent instance, 27 separate studies were prepared before the final route and construction procedure were determined. Before the start of construction, survey crews go over the proposed route to obtain information for plans showing line and grade. The character of the soil and subsoil can be determined by dragging a 20-ton giant ripper over the surveyed line.

Construction planning for a major pipeline project must be performed with military precision to insure a smooth running and efficient operation. Some of the factors that must be considered are:

Scheduling of materials to maintain construction progress.

Offloading, handling, transport, and storage of materials from carrier to double- or triple-ending yards and to right-of-way.

Procurement, scheduling, and transport of tools and equipment.

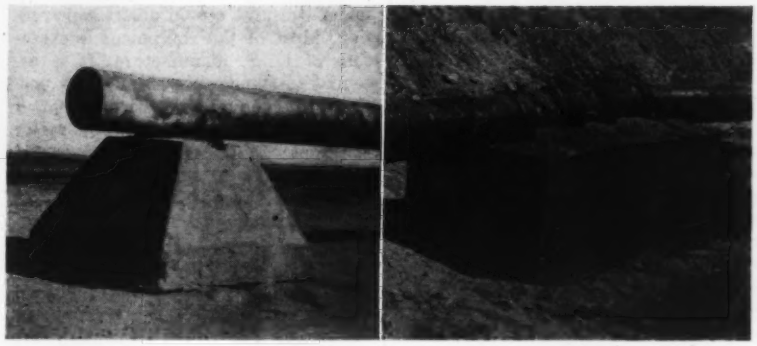
Design, detail, and construction of double-ending or triple-ending pipe fabrication yards.

Storage, handling, fabrication of bends and transport of pipe along right-of-way.

Forecasts of manpower requirements, including specific selection of the classifications required, and scehduling to meet field requirements.

Arrangements for housing and feeding of personnel at base camps and on the line.

Arrangements for transportation of materials, tools, equipment, and personnel.



Commonest form of support for pipe during welding consists of precast concrete blocks, placed on right-of-way in advance of construction. See view at far left. Anchor blocks of precast concrete, like that immediately at left, provide economical and flexible support for Ghawar Field flowlines.

Arrangements for maintainance of tools and equipment.

Provisions for fueling and lubrication of equipment.

Preparation of detailed field cost estimates for the complete project.

With the start of construction, survey parties again go into action, laying out the right-of-way, establishing grades, staking the center line of the ditch, and preparing the finished right-of-way profile. Heavy equipment is then brought in. Progress is controlled by soil conditions. Eastern Saudi Arabia, in common with almost all of Arabia, is a desert. As would be expected, sand is the predominant surface material but a variety of materials are present, ranging from swamp to rock. Survey crews working with the spread give grade and stake the ditch cut for excavating equipment, stake location of bends, anchors, drains, vents, and station markers.

Double- or triple-ended pipe lengths are strung along the right-of-way, bends and anchors being prefabricated whenever possible. The terms double- and triple-ended are applied to pipe lengths prefabricated from two or three mill lengths into a pipe section 60 to 90 ft long. Prefabricated sections of small-diameter pipe are restricted to lengths that can be handled without excessive deflection, to avoid buckling due to bending. Where the pipeline crosses wet areas, it is usually installed above ground and supported by piling, the pipe being anchored to the pile supports by welded ring girders. More generally the pipeline is buried in an excavated ditch, and after backfilling the ground surface is oiled to stabilize it.

Travel over the desert is not as difficult as it might appear since desert soils in an undisturbed state will permit the use of vehicles equipped with sand tires in almost all areas. Once this material is disturbed, however, transportation by wheeled vehicles becomes more difficult. Marl surfacing of the right-of-way provides a stable and adequate surface for wheeled vehicles, but can seldom be justified and is not the usual practice.

Primary construction is the excavation of the ditch, which brings into operation a wide variety of earth-moving equipment. On a major pipeline, the equipment used on the spread will include practically every type of heavy duty equipment now manufactured. Where hard marl or soft rock is encountered, a 20-ton giant ripper may be dragged over the ditch line by three to eight D8 dozers. This will break up the material sufficiently to permit its removal. Hard rock calls for pneumatic drilling and blasting. Drilling is performed using twin and quad drill frames suspended from sidebooms as well as conventional jackhammers. The sidebooms supporting the drills also tow the compressors required for their operation.

Powdermen follow the drillers, loading and shooting the holes. They operate as an independent unit under an Arab contractor. The Arab contractor's personnel is usually supervised by a foreman furnished by the foreign contractor. Operations are mobile, all equipment being mounted on a flat-bed truck, including reels of blasting wire and an electric generator. When blasting has been completed, the ditch may be backfilled to permit reexcavation by backhoe or dragline. As most of the rock encountered is a porous limestone, drilling and blasting may have to be repeated to secure the design grade.

During right-of-way construction and ditching, fabrication of pipe into sections containing two or three lengths will be in progress at a fabricating yard convenient to stocks of incoming pipe. On a large pipeline project, a complete fabricating yard may be constructed. On smaller projects it may be possible to utilize existing yards or rehabilitate an abandoned yard. In the case of the construction for Tapline, a large fabricating yard was built on the shore of the Persian Gulf, and pipe was transported from ships anchored offshore by over-water tramway.

Provision must be made in the fabricating yard for stocks of incoming materials as well as fabricated products. Welding together of two or three mill lengths is performed on raised skids constructed of pipe or rails. These skids serve as a production line, areas being designated as stations for the preparation of pipe ends, line-up, stringer bead, hot pass, and cover pass. Welding is facilitated by the use of air motors which rotate the pipe through rubber rollers at the different stations. Stringer bead welding is usually performed by a foreign contract employee, and the subsequent hot and cover passes by an Arab contractor's personnel.

To maintain efficient working conditions in the fabricating yard, the fabricated pipe must be removed and strung along the right-of-way as soon as possible. The fabricated pipe may be in place along the line some time before the fabricated units are welded into a continuous pipe, this welding being performed on timber cribbing. Cribbing composed of 8 x 8 timbers 4 ft long, and spaced approximately 100 ft on centers, provides temporary support during the welding and wrapping operations. Such support in some cases is provided by sand bags instead of timber cribbing and represents a general practice on flow-line construction. Flowline supports in the past were constructed from scrap pipe usually in the form of a tee, but at present the predominant flowline support is a precast concrete block. These blocks are placed on the right-of-way in advance, and serve as supports for construction operations also.

Strong winds are a major obstacle during welding operations. These winds, which carry sand in suspension, are quite common over the entire year. Since they may last for a number of weeks, plywood shields which protect the welders offer some small relief, but high-intensity winds usually result in the suspension of work.

Major fabrication is performed at the double- or triple-ending yards whenever possible. Bends are field fabricated to suit line conditions. Flowline expansion bends are fabricated using a sideboom equipped with a bending shoe. In this operation also, the Arab craftsmen have developed to the point where they can fabricate the entire flowline without the use of foreign contract supervision.

Visual inspection of all welding operations is the first of the testing operations. This is followed by an air-soap test when a string is completed. Strings on large lines have a length of approximately 3,500 ft. As a quality control measure, about 10 percent of all welds are given radiographic inspection; this reduces the amount of repair work by disclosing defects in advance of final testing by hydrostatic pressure.

Cleaning and priming of large lines is done by an over-the-trench cleaning and priming machine while the pipeline is supported on cribbing adjacent to the excavated ditch. If a flowline has only intermittent buried sections, where the line crosses under roads or camel crossings, cleaning, priming and wrapping of such sections is done by hand.

Protection of buried pipelines against corrosive and abrasive forces is accomplished by using standard coating and wrapping procedures. Since desert soils are highly corrosive and have a high salt content, buried lines are also provided with cathodic protection. Details of construction procedures, including the cathodic protection for the Trans-Arabian pipeline between Qatif and Qaisumah were described by Kenneth R. Wright, in the May 1956 issue of CIVIL ENGINEERING.

Cleaning, priming and wrapping are probably the most interesting operations in the construction of a pipeline. During wrapping, two side booms precede the wrapping machine and raise the pipeline from the temporary support cribbing. Lifting is accomplished by roller pipe cradles, a frame containing three large rollers. Spacing of the cradles is maintained within the maximum spacing specified for the diameter of the pipe and its wall thickness. When this spacing is exceeded, high bending stresses are induced in the pipe, and buckling may occur. The maximum permissible spacing of cradles for 30-in. pipe during the lifting operation is 140 ft.

To start wrapping operations, the wrapping machine is installed on the pipe at the beginning of a string, the pipe having previously been cut for tie-in. The wrapping machine is self-propelled and asphalt in a liquid state is supplied to it through a metallic hose connected to two 25-bbl asphalt kettles mounted on a trailer and towed by a sideboom. Asphalt in cartons is supplied from a materials truck which travels with the spread and carries sufficient supplies for continuous operation.

The first coating the buried line receives is a petrolastic primer followed by a heavy coat of petrolastic asphalt having a melting point between 235 and 250 deg F. Temperatures of materials exposed to desert sun approach 165 deg F. Wrapping consists of one wrap of 20-mil glass pipe wrap followed by a 35-mil asphalt impregnated glass wrap with a coating of asphalt between. As the wrapping operation moves forward, the wrapped pipe drops back on the cribbing. The wrapped line is then lowered into the ditch and tie-in welds are made at design temperatures.

When the line has been completely welded, a pig is blown through it by compressed air to insure that no foreign material has been trapped inside. Many stories of lost pigs can be told. To facilitate locating the pig in case it stops moving, a radium-irradiated pill is placed in the pig so that it can be traced with a Geiger counter. Final testing is performed with hydrostatic pressure, which must be maintained for a 24-hour period. During testing, pressures are recorded on a chart for future reference.

With the conclusion of the day's work, all equipment on the spread not in use is assembled at locations convenient to the working areas, and lined up like a train. Such positioning facilitates maintenence, lubrication and fueling. Arab contractors provide the manpower for these operations. All maintenanec equipment is mobile. Supplies for lubrication are mounted on flat-bed Kenworth trucks, and fueling is performed by a 2,000-gal Kenworth tanker divided 50-50 for gasoline and diesel fuel. Repair and maintenance is performed by heavy-duty mechanics furnished with WDX trucks. Illumination is provided by floodlights mounted on the truck beds as all operations are performed at night.

Field experience has shown that only small quantities of foreign construction equipment have the maneuverability and stamina to stand up under constant use on desert construction. Most of the equipment is therefore of U. S. manufacture. It is essential to standardize as much as possilbe to keep stocks of parts at a minimum. All repairs except major overhaul can be accomplished in the field. Breakdowns which require major overhaul are loaded on low-bed trailers and backhauled to a district heavy-duty shop.

Construction costs on completed pipeline construction projects present a study in contrasts. Costs cannot be reduced to a common correlation factor although long lines will tend to show greater economy than short lines where the pipe diameter is the same. Some indication of costs in recent years is given by price comparisons based on costs per foot per inch of diameter. During 1952, construction of 259,293 ft of 30- and 31-in. pipe cost 68 cents, and in 1953, only 2,000 ft of 20-in. pipe cost $2.04. These of course are extreme comparisons. An analysis of 16 projects constructed between 1952 and 1955 showed an average cost per foot per inch of diameter of 97.2 cents. Of this figure, 44.7 cents represented the material cost. On the basis of the comparison given above, material costs have remained stable within a small range but construction costs have varied in an erratic manner. Price trends have been increasing at a rapid rate in recent years as a result of increased mill labor costs and transportation.

Housing for American personnel at base camps is provided by prefabricated houses completely air conditioned. Recreation at the desert camps is provided by motion pictures—the same ones that are shown in the district camps. On the Safaniyah-Ras Tanura pipeline, Aramco purchased a 50-man trailer camp which has every possible facility for the comfort of the men; it is perhaps the most modern of its kind.

What are the inducements that attract people to foreign employment? This is perhaps the most common question put to overseas workers. The most common answer would probably be the ability to earn and keep more money than would be possible at home. To the young engineer, foreign employment offers, in addition to a high monetary reward, an opportunity to assume greater responsibility and reap experience which could not otherwise be obtained in the early years of his career. The older engineer has a feeling of security and early retirement.

The author is indebted to Garland E. Roberts and J. P. Lunde, Acting Chief Engineer, for their helpful review of the preliminary draft.

Prepared from the President's Annual Address presented at the Buffalo Convention

TIME TO THINK

MASON G. LOCKWOOD

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Speed has crowded reflective thought very nearly out of our lives. In this age, pure thinking is an almost complete casualty—as much so as walking or the reading of good literature.

At President Eisenhower's request, the White House staff some time ago revised the Chief Executive's schedule to allow him to devote a part of each day to thinking. The President had complained that the exigencies of his daily schedule allowed him no time to wrestle alone with the problems of his Administration, and to form conclusions and reach decisions before meeting with his advisers.

In all current communication media, the major emphasis is on appeal to mass emotion. Little is intended to stimulate individual thinking. It is disquieting to consider how thoroughly our generation has rejected thinking as a personal process, how quickly it has adjusted to spoon feeding for all forms of intellectual nourishment.

Man is, I believe, an unwilling victim of today's environment, caught up in a system which places an inordinate premium on speed, a system with little patience and less reward for a man known to be given to reflection. Tension has become the badge of initiative, nervous restlessness the emblem of useful drive. Certainly an earlier grave is not the goal: men only behave as if it were.

The influences which have so robbed us of time that little is left for creative thinking have perhaps struck hardest at the lives of business and professional men. And the more creative the activity, the greater the blow. Thus the engineering profession, for one, is especially hard hit.

The problem is that only relatively few engineers, however creatively disposed, are able any more to find the time to think—except frantically, in a pressurized atmosphere. Such an environment, we have been led to believe, fires imagination and induces creativeness in journalism. In engineering, it seems almost to have the opposite effect.

One source of this difficulty is competition—of one sort or another—not so much the sort of competition that keeps this country strong and phenomenally productive, but rather that which inspires efforts to transform engineering art into routine mechanics, to apply mass production methods to engineering so as to compete more effectively.

I do not oppose the application of advanced techniques for the mass solution, presentation or handling of laborious, time-consuming problems. Developments that save time and money without sacrifice of essential quality are indeed the very essence of the engineering art.

But the sharp distinction between these engineering-related routines and original creative engineering is being obscured. Widespread evidence of this is to be found, and the degree of abuse usually increases with the number of engineers in a particular discipline. Industry is thus the chief offender, but government and private practice are hard at its heels. Engineering management seems not to recognize that almost all engineers—indeed almost all people—are creative to some degree.

Business clearly recognizes the need for imaginative management. Moreover business, industry and even government count heavily on research, a pursuit for which they readily afford time for contemplation. None of these seem consistently to recognize that engineers do much research—or that they might

well do far more to good advantage if they had the time and the essential atmosphere.

Relatively few engineers are able any more to apply the amount of uninterrupted thought necessary for the optimum solution. Time simply does not permit this. A harsh deadline has to be met. Administrative details cannot be shelved. Personnel problems won't wait. Conference demands must be satisfied. Telephones are insistent and persistent. People must be met, courtesies extended. Meetings must be attended. Family demands can't be ignored. Social amenities are essential, civic duties demanding.

In this atmosphere, thinking is spotty, uncoordinated and appallingly inefficient. The best solutions are not achieved. Short cuts are contrived in desperation. These are usually based on methods copied from similar applications. But this does not necessarily lead to the best solution.

The shortened work week is a factor in the vanishing time for thinking. The professions, including engineering, have always lagged behind wage earners in adopting shorter hours. Self-employed people traditionally work longer. And this is true of engineering. However the vast majority of engineers these days are in the employee category. Nearly all of that group have the standard forty-hour work week, or in some cases an even shorter one.

Although self-employed engineers and others deriving their income wholly or in part from profits usually work substantially longer than the standard work week, their hours are influenced by the standard pattern of employed personnel. And the nature of the work they do in this excess time is usually quite different from that done during regular hours. Probably the overtime hours are their most thoughtful and most productive.

We have less time for thinking, not only because we are at work fewer hours but also because we use more and more of these fewer hours for other things. Much of the lost thinking can be accounted for. The theoretical eight-hour day in engineering offices actually averages no more than 6¾ hours. For many it is much less. At least 1¼ hour per average day goes to vacation, sick leave, excused time off, recreation breaks, and other non-productive time. In higher grades, another ¾ hour per day may go in conferences and travel.

If engineers are to have more time to think—as they once did—this time will have to be salvaged either from what is left of the working hours, or from the non-working hours, or both. This is an individual problem for all engineers. In the case of employed engineers, it is also a management problem.

Individually, the most promising areas for improvement would seem to lie in the elimination of all possible time-consuming, non-essential distractions. This means, first, improved personal efficiency. It means also release from all routine and administrative details that can be handled by subprofessional or clerical assistance.

In the case of supervisory or administrative engineers, it means delegation of more responsibilities. This must be done even though those to whom the responsibility is delegated are either thought to be or known to be less competent. Here many of us fail miserably. Almost invariably we underestimate the ability of others to assume responsibilities we have been handling. And if we have perfectionist tendencies, the delegation problem is even more aggravated.

One notorious thief of time strikes at all engineering levels—on-the-job social visiting with associates and, to a lesser extent, with outsiders. The twice-daily recreational breaks, which have come to be an accepted and wholesome part of American business, industrial and professional life, are proper times for such visiting. But abuses are reported everywhere. Probably the only effective remedy against excessive visiting is personal discipline. A thinking engineeer who longs for more time for thought while at work might well examine and improve his personal habits in this regard.

Engineering entails much personal communication between design and supervisory personnel, and between designers and sales representatives of manufacturers and suppliers. Those directly or indirectly interested in the sale of a product for incorporation in an engineering undertaking must, to be successful, maintain personal contact with the engineers responsible for specifying materials, equipment, and non-engineering services. The frequency and duration of these interviews is some measure of the sales group's effectiveness. On the other hand, those who specify do lose time as a result of excessively long or frequent sales interviews.

The problem is a difficult one. Under our system of business practice, selling agents are entitled to a full hearing. Indeed they make a significant contribution to engineering. But it is both good judgment and acceptable professional etiquette to limit sales interviews to the amount of time really required. The necessary discipline must be initiated by the engineer representing the ultimate owner or purchaser, not by the sales representative.

In administrative, executive and supervisory capacities especially, the telephone is at once a tremendous time-saver and an astounding time-waster. Most telephone conversations during working hours are unnecessarily long. Usually they could be shortened materially without either reducing effectiveness or infringing courtesies.

Nearly all engineers of professional standing are obliged to participate in conferences of one kind or another. These conferences probably use, on the average, twice as many man-hours as necessary. Several factors are chiefly responsible for wasted conference time. The greatest, perhaps, is inadequate planning. Curiously, good planning is considered the special forte of the engineer. Another notable thief of time in conferences, also traceable to improper planning and direction, is the tendency to deal with matters affecting only a minority of those present.

Inadequate and incompetent stenographic and secretarial assistance is a frequent and usually valid complaint of engineers, especially of those in situations requiring considerable use of such services. For an organization not to provide adequate stenographic services for its engineers is very high-priced economy. This would be true even in times when engineers are not critically few. Yet this is perhaps one of the most common time-thieves.

In his effort to recapture some time for thinking, the engineer might well examine the way in which he makes use of the secretarial help available to him. Sporadic dictation throughout the day, rather than concentrated, uninterrupted periods of dictation, is wasteful. Another common and avoidable fault is that engineers fail to make full use of their secretary's or stenographer's ability to compose, after only the briefest directions, the routine letters comprising a large part of an engineer's correspondence.

The wasted minutes throughout every work day would, if collected, comprise a respectable total of perhaps an hour or two. This fact, coupled with the easily-overlooked responsibility of every engineer to make some use of his own time to his and his job's advantage, leaves us with less excuse for the current deplorable state of our workaday schedule.

Granting the difficulties compared to those, say, of a century ago—or even of twenty years ago—it is still possible to supply oneself with time to think creatively. Only by finding a way to do so can an engineer, or any professional man, fulfill his ultimate responsibility. It is an effort—and not an easy one—which can originate only within the individual.

The Greek Architekton — Part 2

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The water supply of Samos, previously noted, like that of many provincial Mediterranean towns even today, was brought to a public fountain at which the inhabitants filled their water jars. Similar public supplies were early provided in other ancient Greek cities. Clay not being suitable, and metals not available for pressure pipe, both the Greeks and the Romans almost invariably sought "supporting ground." Their water lines followed the hydraulic gradient. When a valley had to be crossed, the Romans favored an aqueduct bridge, but later attempted to use lead pressure pipe, as we shall note.

Two interesting early, probably Greek, lines of this type have been reported, both in Asia Minor. That at Patara (described by Texier) shows two walls of masonry enclosing an embankment and forming a supporting crossing and culvert over the lower part of a valley bottom. In the embankment, remains have been found of heavy terra cotta pipe and also of bored stone pipe with "hub and spigot" faces. Here were the remains of what was probably a pressure line, but its success or failure is unknown.

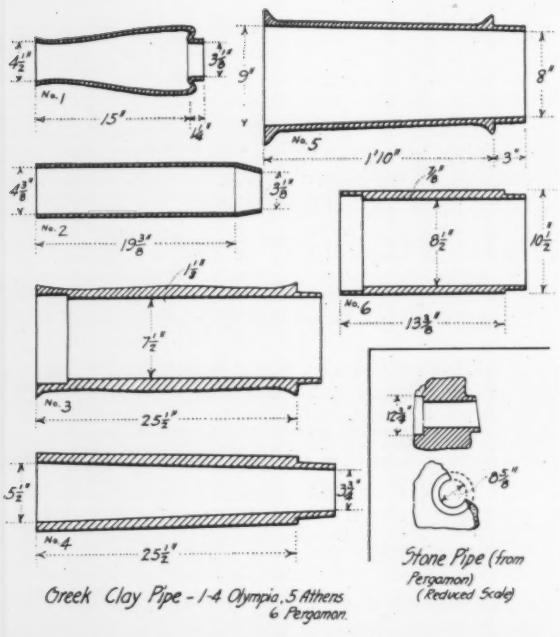
The other pressure line, at Pergamon, was almost two miles long and at one point crossed a valley 780 ft deep. The only remains are solid stone "collars," set on edge, spaced about 4 ft apart and having holes in them 12 in. in diameter. No vestiges of the pipe these collars obviously connected and held in place have been found. Clearly clay tile would not have withstood the indicated water pressure of over 300 psi. Was the pipe metal? Bronze castings of the required thickness would probably not have been beyond the technical skill of the day. And since metal was scarce and costly, such pipe would undoubtedly have been removed ages ago, as this seems to have been. Many of the collars are broken, apparently the result of such removal. This structure may have been a tour de force in pipeline history, which had no parallel for many centuries.

The world's first harbor

Herodotus in his famous history notes that the harbor of Samos was worthy of special mention. He was greatly impressed by the breakwater, which had, as he describes it, two remarkable characteristics. It was a quarter of a mile long and was built in water 120 ft deep. To us its major interest lies in the fact that it was the first recorded harbor construction and apparently became the prototype in harbor planning followed all through ancient, and also well down into modern times.

The sea was a vital, a fundamental part of Greek life not only because of the physical barriers that discouraged the development of land routes but because it was the means of reaching foreign markets, essential to the

Pressure lines for water supply were very rare in ancient times. In fact only two, probably Greek, have been found, both in Asia Minor. Photograph shows that at Pergamon, where only stone collars remain. Those at top are complete while lower ones, like those on greater part of line, are broken away on upper side. This breakage was probably caused by removal, in antiquity, of valuable metal pipe sections spanning between the collars.



Greeks generally used clay pipe for water lines, which followed hydraulic gradient. Cross sections of clay pipe at left (Nos. 1-4) are from Olympia, that at top right (No. 5) from Athens, and the last (No. 6) from Pergamon. Inset, to reduced scale, shows stone pipe from Pergamon.

growth and expansion of industry and commerce. After the Persian wars, agriculture in Attica no longer produced all the food needed in the area, and Greek ships sailed the Mediterranean, exchanging the output of Attic industries for food and other products from foreign lands.

From 450 B.C. onward there is evidence of specialization of labor in industry—supposedly a modern invention. Xenophon wrote, "It is impossible for a man who is jack-of-many-trades to do all things well." But increased production rather than fine workmanship was undoubtedly the major consideration in fostering specialization. In a sandal factory, for example, one workman might be employed exclusively in cutting out, in stitching, or in some other single operation. Wholesale trade in such industrial products encouraged the building of larger merchant ships and of harbors to shelter them.

In general the Greek harbor plan consisted of two encircling breakwaters with a narrow harbor entrance. The breakwaters supported a continuation of the city walls, thus providing a defensive fortification encircling both the city and its harbor. Athens, being three or four miles inland from its port of Piraeus, posed the greatest problem of this type the Greeks had to face. About 460 B.C., in the early part of the Golden Age of Greece, Pericles, foreseeing the coming struggle with Sparta, strengthened the fortifications of Athens and induced the people to connect the city with its harbor by building the two famous "Long Walls." The result was one of the major constructions of ancient times—a completely walled-in road between the harbor and the city fortifications. Allowed to fall into decay in later Hellenistic times, the walls were demolished by the Romans about 86 B.C., and we unfortunately know little of their size or character.

Another Greek structure which reflects the importance of navigation is the Diolcos. The lower peninsula of Greece, the Peloponnesus, home of the Spartans, was almost completely cut off by the Gulf of Corinth, but a narrow isthmus remained. In early times, perhaps contemporary with the harbor work at Samos, a roadway some 3½ miles long was built across this isthmus. Over this route smaller ships were drawn on rollers, and the cargoes of larger ones were moved for transshipment. The Roman Emperor Nero started a tunnel here for the passage of ships, but it was not until 1893 that the problem of avoiding the long passage around the Peloponnesus was solved with the opening of the Corinth Ship Canal.

The interest in navigation led also, in much later Hellenistic times, to the building of the first lighthouse in the world, the Pharos at the port of Alexandria. This structure, said to have been 370 ft high, was built by Sostratus of Cnidus shortly after 300 B.C. and stood for some sixteen centuries. It finally fell in 1326 A.D. In style it appears to have reflected the oriental influences of the period, and it may have been the prototype for the bell towers, or campanili, later erected beside cathedrals in Europe.

The Pharos was rated one of the Seven Wonders of the Ancient World, and in this connection it may be of interest to recall that there were apparently numerous tourists and sightseers in those days, since many guidebooks were prepared for them. About 200 B.C., Antipater of Sidon, the Baedeker of his day, selected seven sights no thoroughgoing sightseer could afford to miss—the Pyramids, the Hanging Gardens of Babylon, the statue of Zeus at Olympia, the Temple of Artemis at Ephesus, the Mausoleum at Halicarnassus, the Colossus of Rhodes, and the Pharos of Alexandria.

Although these could all be classed as works of art or architecture rather than engineering, they all were founded on a rich background of engineering knowledge and experience. Herodotus, as we have noted, seems to have fully appreciated the importance of this engineering skill in early days. But we must also study building construction in ancient times to fully appreciate advances in structural knowledge and construction methods. There are two reasons for this—the fact that architecture and engineering went hand in hand, and that structures of the type we would now call distinctly engineering works were somewhat of a rarity before Roman times.

Mnesicles and Ictinus, building experts

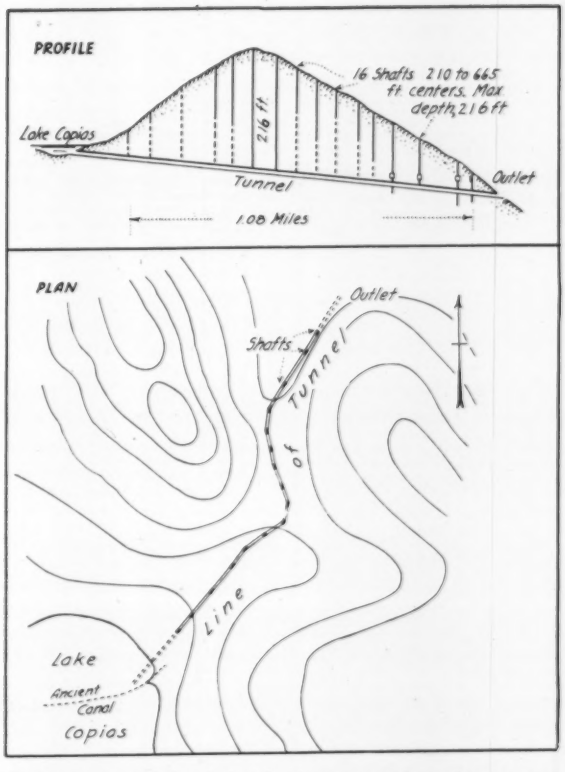
Although the ancient Greeks lived in simple houses lacking any modern conveniences, they built some of the most beautiful temples and public buildings ever constructed. As with earlier Egyptian works, these structures utilized only two basic structural forms, the post or column and the beam or lintel. The later Romans were the first to make extensive use of the arch. The only structural innovation

that may be attributed to the Greeks is the timber roof truss, but of this not a vestige remains. In their use of the column and beam, however, the Greeks showed an understanding which, although purely qualitative and stemming from experience and observation rather than from quantitative mechanical analysis, yet marked a new level in structural understanding.

Thus the evolution of the three major Greek building styles—Doric, Ionic, and Corinthian—although unquestionably reflecting changing public interests and tastes, also reveals increasing structural understanding. The early Doric column was a simple, heavy compression unit, seldom smaller in diameter than one-fifth or one-sixth of its height. The Ionic column which followed was more slender, reflecting the increased confidence of the builder in the capacity of stone to support compressive loads. Finally, in the Corinthian column, the Greek *architekton* used a slenderness ratio of diameter to length as low as 1 to 12 or 14, thus achieving what we recognize today as the limiting ratio between the purely compressive column and that in which bending plays a vital role.

To the modern engineer the fact that the Greeks also pioneered in reinforced stone beam construction—anticipating the basic principle of modern reinforced concrete—is likewise surprising. Metal dowels and cramps were, of course, widely used to hold stones in position in lieu of or in addition to cement. Also, although no metal has survived, rust marks in recesses in the pediments of the Parthenon and in the bases of the sculptured figures that decorated them, show that these heavy figures were supported by wrought-iron cantilever brackets. In the Propylaea, gateway to the Acropolis, some of the intermediate marble ceiling beams did not rest directly on the marble girders spanning between the columns. They were supported on a wrought-iron beam of about half the girder span set in a groove cut into, but free of, the top of the exposed stone girder, thus distributing the concentrated load to the quarter points. In the Erechtheum, we find an iron bar leaded into and reinforcing the under side of a lintel over a lower doorway.

Clearly such builders as Mnesicles and Ictinus had observed the usual failure of beams by cracking in the lower, tension face and had realized that stone, in spite of other admirable qualities, was weak in its capacity to withstand tensional forces. The stronger iron was at least sufficiently plentiful to permit its limited use in construction, and the keenly observant and inventive mind of the Greek did not fail to employ it. See "Structural Iron in Greek Architecture," by William B. Dinsmoor (*American Journal of Archaeology*, 2nd series, Vol. XXIV, 1922, No. 2).



Drainage tunnel for Lake Copias was driven from many shafts following ancient practice. Shafts at right were deepened after start of project, to increase tunnel gradient to over 1 in 100. In plan, below, note that builder followed curved alignment to keep as close as possible to the low points of crossing over mountain, thus decreasing depths of shafts. Tunnel was nearly completed when work was discontinued for some unknown reason—probably military campaign of Alexander the Great in this area, known as Boetia.

Early Aegean stonework is often of the polygonal type, with close joints but without coursing. This soon gave way to ashlar masonry with regular bedding and rising joints. In general, stones of moderate size were used, columns for example being built up of successive drums. The Greek builder seems to have been very conscious of loads, perhaps even timid and afraid of overloading his structures. In the Parthenon the face stones in the walls were placed with open spaces between them almost large enough for a man to pass through. Headers bound these faces together, and it is surmised that this construction was used to reduce the load on the lower wall.

For erection, the Greek builder had at his command timber frames and hoists operated by manpower but equipped with capstans and pulleys similar to those used in modern times. Ancient writers relate how Chersiphon moved the one-piece columns for the temple of Artemis (Diana) at Ephesus some 8 miles from the quarry by rolling them, enclosed in round wood frames, using ox teams. Of course this temple was one of the Seven Ancient Wonders, but it would appear nevertheless that the dimensions of these stones as given in ancient reports (7 ft in diameter and 60 ft long) were a gross exaggeration.

On occasion, the *architekton* was able not only to transport but also to lift very large and heavy blocks. Stone girders weighing 60 tons were raised to a height of 50 ft. He also developed a hydraulic cement, the first known, which was made by mixing Santorin

earth with lime. It was thus similar to the Roman pozzuolana cement, the only type available until the discovery of modern hydraulic cement in the nineteenth century. But unlike the Roman builder, the Greek did not develop extensive uses for cement.

Of the *architekton's* foundation work we know little other than that he built on rock whenever it could be easily reached.

Hippodamus of Miletus, father of city planning

Another field of engineering to which the Greeks made contributions is city planning, and the name of one of the earliest practitioners in this field is known. Hippodamus is said to have been a physician who became interested in city planning as a step in securing a maximum of healthful light and air. Apparently he rebelled against the crowded and irregular street patterns of the cities of his day, and to him can be attributed our modern use of rectangular blocks with straight streets and avenues running at right angles to one another.

He became famous as an *architekton* and was called to Athens by Pericles about 460 B.C. to lay out the port of Piraeus. Here he followed a true checkerboard pattern which centered on the *agora*, or place of assembly for the transaction of public and private business. The *architekton* who later laid out Alexandria, Dinocrates of Macedon, followed this same plan. Variations appear but the basic Hippodamian pattern was generally followed even when the topography would have suggested some other arrangement.

Crates of Chalsis, tunnel engineer

The identification of men of medicine with early engineering works, which began with Imhotep in Ancient Egypt, is to be noted also in the career of Empedocles of Acragas, a physician, philosopher, poet and orator of about 500-430 B.C. who has been characterized as the Leonardo da Vinci of Acragas. He is said to have driven pestilence from the city of Selinus, near his home in southern Sicily, by draining marshes and changing the courses of rivers. Thus in ancient Greece engineering began to join with medicine to provide a more healthful environment for man, a collaboration that is still making contributions to public health.

Undertaken for a different purpose, the drainage work of another Greek *architekton* is of interest. Some forty miles northeast of Athens in Boetia a land-locked body of water, Lake Copias, was flooding the fertile agricultural lands surrounding it because its natural outlets were clogged or inadequate. About 325 B.C., in the Hellenistic Age that followed the conquests of Alexander the Great, Crates of Chalcis made an ambitious attempt to provide an outlet to control the lake level. Crates is described as a *metalleutes*, or miner, and later, in connection with his tunnel work for the water supply of Alexandria, as a *taphrorychos*, which we would translate as tunnel engineer. While his Lake Copias project was never completed, there can be no doubt that he had the work well in hand and would soon have holed through his tunnel, when some unknown disturbance caused the work to be discontinued—probably Alexander's military campaign in this area, Boetia. The modern drainage work on this lake, begun by a French company in 1883, was completed under British direction in 1889-1894. (See *The Engineer*, London, July 9, 1886.)

The practice of driving many shafts for a tunnel, sometimes spaced only 200 ft apart, or even less, may be regarded as standard practice in Greek and Roman times. The resulting multiplication of working faces was especially desirable in view of the laborious hand excavation methods of the day. This is still standard practice where shaft depths are not excessive. At Copias, Crates sank 16 shafts about 5 ft square at intervals of 235 to 665 ft, some as deep as 216 ft. This raised a problem of economic alignment, which Crates clearly appreciated and effectively met.

Instead of following a straight line between portals, as would be most economical where work was carried out from only two headings as at Samos, Crates adopted a curving alignment, following close to the line of the lowest crossing over the mountain under which his tunnel passed. (See accompanying sketch.) This increased the length of the tunnel somewhat but reduced the depths of the shafts, thus achieving an economical balance between shaft sinking and tunneling.

Apparently the planned grade of the tunnel was changed in the course of the work, since some of the shafts were deepened and new, lower tunnel headings were well under way when the work ceased. The length of the lower tunnel would have been almost 1½ miles and the grade a bit over 1 in 100, an excessive figure. Clearly the decision as to grade was not subject, as it would be today, to computation, but was left to the judgement of the designer.

(Additional informative material on Greek engineers and engineering will appear in a subsequent article by Dean Finch.)

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Early difficulties encountered in the manufacture of prestressed concrete members for Florida bridges have been ironed out, and improved techniques have been developed. As a result, the advantages of prestressing now far outweigh its shortcomings and prestressed members have almost completely replaced other types of construction for bridges built by the Florida Road Department.

A controlled mix, moderate curing heat, careful stressing for camber control, elimination of sharp changes in form shape, and use of web reinforcement beyond theoretical needs are details that have been found valuable in developing prestressing techniques.

The two types of prestressed members that have become firmly established in Florida bridge practice, to the near exclusion of other types, are piles and I-shaped beams for trestle spans. Both are cast on well-made beds with accurately built forms and good stressing equipment. Economy dictates a rapid "turnover," which means concrete of uniformly high strength at an early age to permit prompt handling.

Some Florida plants use very rich mixes—8½ bags or more of Type III cement per cu yd. With such mixes and steam or hot-water curing, cylinder strengths of 3,000 to 4,000 psi in 24 hours have been produced.

On Florida bridges, rich mixes have been avoided. Necessary strengths are attained by very careful proportioning, the use of plasticizing, densifying admixtures, and a cement content of not more than 7 bags per cu yd. After much experimenting, a standard mix employing 6½ bags of cement per cu yd and certain approved admixtures has been developed. Use of Type I or Type III cement is left to the producer's option. With the steam or hot-water curing generally employed, most producers are using Type I. With this mix and natural Florida aggregates, concrete is consistently being produced with a strength of 4,000 psi in 5 days using conventional curing methods and

PRESTRESSED CONCRETE—

Difficulties overcome in Florida bridge practice

average temperatures not below 60 deg F. With steam curing 4,000-psi strength is generally obtained at 48 hours. The strength at 28 days is consistently above 5,000 psi.

Strength controls movement

Stress transfer is made only after the concrete has developed a specified minimum strength, judged by cylinders cured exactly as the prestressed members are cured rather than by any standard methods. Since speed and economy require that strength data be constantly available, cylinder breaking machines have been placed in the yards of all major producers so that cylinders do not have to be sent to a central laboratory.

In a conventional reinforced concrete beam the maximum stress to be resisted is a combination of dead and live loads that is applied only after the structure is completed—if ever. In contrast, the maximum stress applied to a prestressed beam usually occurs at a very early age under stress transfer. Subsequent loadings usually reduce this initial stress as do all losses, such as creep. For this reason a prestressed beam is usually a pretested member. If it behaves as expected under the stressing operation it can be expected to give satisfactory service under subsequent loadings.

A peculiar but logical characteristic of prestressed concrete is camber of members. Immediately after a beam is stressed there will always be a heavy compressive stress in the normally tensile fibers and little or no stress in the fibers on the opposite side of the member. This results in a humping of the beam when stress transfer occurs. This camber is likely to increase because of plastic deformations unless it is countered by the application of additional dead load. Under full dead load, if the top and bottom fibers of a beam are at about the same stress, camber may be expected to be checked. If the bottom of the beam is under stress that will tend to shorten the lower fibers as compared to the top fibers, camber will increase. If the top of the beam is under appreciably greater compressive stress than the bottom, sagging will occur until a state of plastic equilibrium is reached. Stress conditions under various stages of loading should be examined and deflections calculated for instantaneous and delayed strains. Deflections cannot ordinarily be predicted with the accuracy expected for structural steel.

The operation of stressing introduces an ingredient of manufacture that must be as closely proportioned as any other construction factor. It is imperative that the quantity of stress be checked by both the elongation of the tendons and by jacking pressures, and that results be reconciled within specified limits. Neither method of measurement is sufficient in itself.

Friction between sides of ducts and tendons is a principal cause of disagreement between the two methods of measurement. Tangling of cables in a long pretensioning bed has been another. It is often necessary, in order to overcome friction and compensate for anchorage losses, to over-elongate and then slack off. Final acceptance of a member will generally be based on elongation of the tendons, but to avoid dangerous overstressing and general abuse, jacking pressures must be known at all stages of manufacture.

Early experiments on prestressed piles established a criterion of about 800 psi as the proper initial stress at transfer. It was evident in these early experiments that with a pile stressed to 400 psi, the rebound effect, particularly when driving in plastic materials, was sufficient to set up tensile or shearing forces that would destroy the pile. Piles stressed to 800 psi seemed almost indestructible with customary driving equipment. This empirical initial stress of about 800 psi has been verified by the entirely independent experience of several other investigators.

With this amount of stressing and the usual pile cross sections, single-line pickups are used for lengths of about 70 ft without stress reversal. Such piles will withstand very severe driving. Conventionally reinforced piles will require two- or three-point pickups and will not stand as severe driving.

One occasional disadvantage of prestressing comes when a pile is driven below grade without developing the necessary resistance. With a reinforced pile in which about 2 percent of the pile area is used for bar reinforcement, a substantial splice can be made by lapping or welding the bars. The pile can be built up and driving continued after the concrete in the built-up section has cured. The small cables used for prestressed reinforcement generally comprise only about ½ of 1 percent of the pile area. This small steel area is insufficient, as non-stressed reinforcement, for a suitable splice. Where further driving is not necessary, a splice can be made by lapping the cables with bars and drilling in a few dowels, but if further driving is needed the usual procedure is to pull the pile and substitute a longer one.

Eliminate sharp angles

Prestressed beams, with spans up to about 100 ft, are particularly adapted to mass production in standard shapes

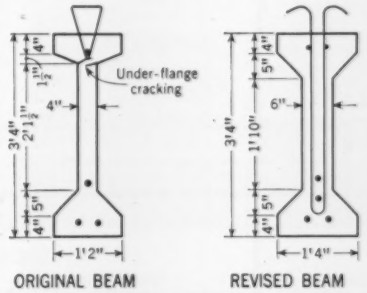

FIG. 1. Prestressed I-beam design for trestle spans of Lower Tampa Bay Bridge was revised to avoid sharp reentrant angle under top flange.

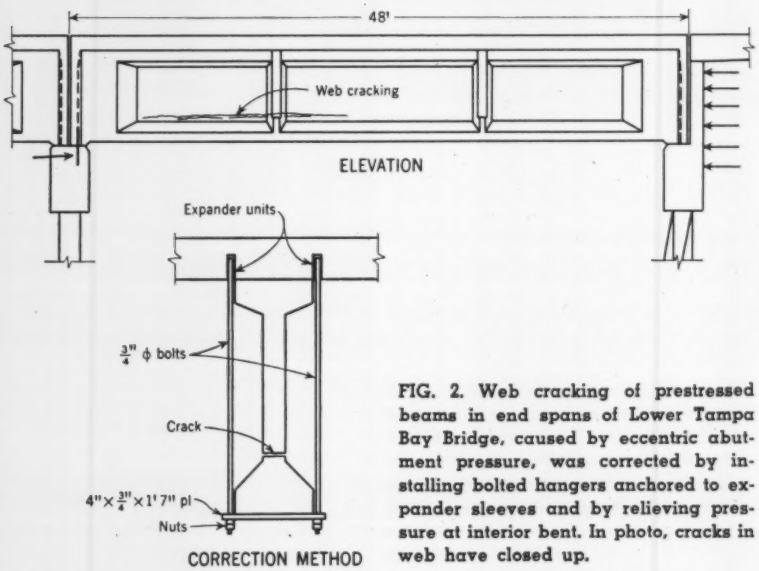

FIG. 2. Web cracking of prestressed beams in end spans of Lower Tampa Bay Bridge, caused by eccentric abutment pressure, was corrected by installing bolted hangers anchored to expander sleeves and by relieving pressure at interior bent. In photo, cracks in web have closed up.

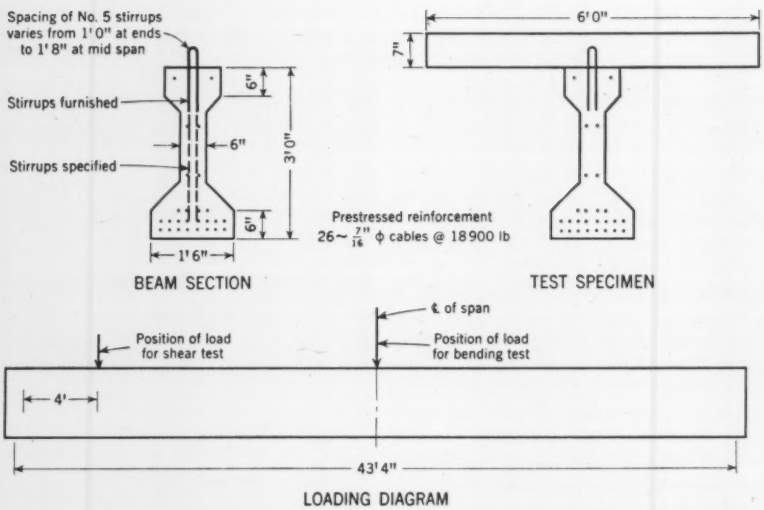

FIG. 3. Inadvertent omission of web steel in several beams for large Florida bridge job illustrates advantage of using some web reinforcement in prestressed I-beams. On beam selected at random for testing, concrete slab was cast to simulate bridge section, as at right. Load deflection curve for bending test on this beam is given in Fig. 4.

at centrally located yards. For uniformity of production, accuracy, and high quality of casting, the use of steel forms and concrete-floored casting pallets is desirable. In the manufacture of I-beams in steel forms, it has been found that changes of slope between intersecting planes should not be abrupt and all corners should be generously rounded.

A cross section of the prestressed I-beam used in the 363 trestle spans of the Lower Tampa Bay Bridge is shown in Fig. 1. This was the first prestressed bridge job in Florida and received world-wide publicity in the technical press. The slope of the under side of the top flange, at 1½ in. in 5 in., makes a rather severe reentrant angle with the web of the beam. The forms for these beams were of very rigid steel construction, and all casting was done on concrete slabs. In production, it was found that initial casting of the full depth of the section frequently resulted in cracking of the web at its junction with the bottom flange, due probably to shrinkage of the concrete. This condition was further complicated on hot days by vertical expansion of the steel forms.

Careful casting procedures were worked out. Concrete was placed to the top of the web; the upper flange was filled when the previously cast concrete was approaching initial set; and forms were cooled by a mist spray. These procedures reduced the cracking of the under flange but did not eliminate it. Several beams of this section were rejected and others were accepted with reluctance. Effective control was not accomplished until all forms for this section were revised to use a 45-deg slope on the under side of the bottom flange, with the junction of flange and web rounded to eliminate the sharp break at this point.

Theory not adequate

No structural member, in the writer's experience, has ever been subjected to a more rigorous mathematical analysis than the prestressed beams for the Lower Tampa Bay Bridge. The beams were designed by prestressing specialists, and the design was independently checked by consulting engineers for the project and by the Bridge Division of the Florida Road Department. The section was examined for every anticipated combination of loading. Before final adoption, full-size specimens were tested to destruction, and the tests verified the rational analysis in all particulars.

Principal tensile stresses were computed at values that would not, in themselves, require the use of web reinforcement, and accordingly none was used. It appears that this omission may have been a mistake. The possibility of under-flange cracking, which was not realized during the design period, would alone be reason enough for the use of some web reinforcing. Lately several of these beams have been brought to a state of near collapse because of web failures occasioned by an unanticipated cause.

The method of supporting the 48-ft beams on pile bents is shown in Fig. 2. At bridge ends the foundations are open-type abutments on concrete piles, some of which are battered to oppose pressure from the adjacent fills. Despite the use of battered piles, all the abutments have been subject to small forward movements due to fill pressure. The abutment pressure is applied to the full depth of the beam at one end and is eccentrically resisted by the first interior bent at the opposite end. These forces have caused severe horizontal splitting of the 4-in. unreinforced web immediately above the bottom flange in the outer half of the beams in two end spans. It is probable that collapse of one span where all the beams were thus split was averted only by timely discovery.

Correction was made by installing bolted hangers anchored to large expander sleeves installed in the slab and by relieving the pressure at the interior bent. The hangers merely serve the purpose of vertical web reinforcing, which could have been much more economically installed within the web.

The advisability of using some web reinforcement in I-type beams was again demonstrated by the inadvertent omission of required web steel in several beams for another large Florida bridge job. The web of the beam (Fig. 3), should have been reinforced by extending the legs of the hairpin stirrups for the entire web depth and into the bottom flange. Instead of this, short stirrups were furnished that provided no web reinforcement. Several beams were cast before the error was discovered.

Computations indicated that the principal tensile stress was negligible under working loads, and within acceptable limits, under overloads. It was agreed that the beams would be accepted if a random selected beam withstood a load in shear and bending equal to three times the live load plus impact, the requirement for ultimate overload as given in the Bureau of Public Roads Criteria.

A composite beam section (Fig. 3), was loaded in shear to $3(L+I)$, then raised to $4(L+I)$ without any detectable distress in the specimen. The bending test at $3(L+I)$ produced only minor cracking of the bottom flange, and the test was considered successful at this point. The test continued until the ultimate load in bending was reached at $4.6(L+I)$, as evidenced by the horizontal shape of the load deflection curve (Fig. 4), yet failure came by a very sudden collapse of the web. While the beam could not have taken a greater load, it probably would have sustained the ultimate load for a longer period and been capable of a greater ultimate deflection had the web been properly reinforced.

Both the Criteria for Prestressed Concrete Bridges of the Bureau of Public Roads and the tentative report of ACI-ASCE Committee 323 on Recommended Practice for Prestressed Concrete, recommend the use of a minimum amount of web steel regardless of computed need. From these experiences the writer wishes to add the strongest possible endorsement of these recommendations. Based on nothing more authentic than a vague sense of proportion, the writer also recommends a minimum thickness for webs of beams of not less than 20 percent of the clear height between flange fillets.

Considering the lack of experience and precedent, the observed shortcomings of prestressed concrete in Florida bridge practice have been minor and have been far more than compensated for by advantages. These many advantages have been so distinct that prestressed members have almost completely replaced rolled steel I-beams, reinforced concrete T-beams, and reinforced concrete piles in Florida bridges.

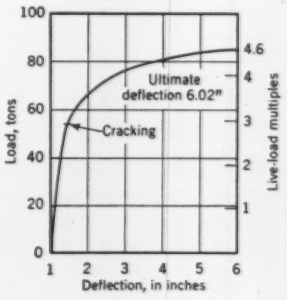

FIG. 4. Load deflection curve indicates results of bending test on I-beam shown in Fig. 3. Beam reached ultimate in bending but failure came by sudden collapse of web, as photo indicates.

Croton Dam has maximum height of 297 ft, only half of which appears above downstream fill. Note spillway at left.

Danger of

Because so many immense dams have been built in recent years, few people realize that when the "New" Croton Dam was built by the Aqueduct Commissioners of the City of New York between 1892 and 1906, it was referred to by the engineering experts of the day as "the most stupendous structure of its class in the world." It is 297 ft in maximum height, although only the upper half appears above the refill placed against the downstream face.

This notable structure has been in the local limelight recently because of the need to practically empty the reservoir in order to repair the 1,000-ft spillway damaged by the record flood of October 1955. These spillway repairs have been adequately described by Arthur C. Ford, New York's Commissioner of Water Supply, Gas and Electricity, in *Water Works Engineering* for January 1957, and in the February *Journal* of the American Water Works Association.

What has not yet been stated is how it came about that the masonry of the curved part of the spillway close to the main dam was badly cracked by an overflow depth of only 3.84 ft over the crest—at 23,000 cfs. This flood, although the highest ever to pass over the dam, would not be considered extraordinary for the tributary area of 375 sq miles. Actually, the spillway had been designed for a possible flood flow 6 ft deep, but with a crest elevation 6 ft lower.

The spillway was designed under the direction of Alphonse Fteley, M. ASCE, Chief Engineer of the Aqueduct Commissioners, with a crest elevation of 196 above sea level for the entire 1,000 ft of its length. (The dam as originally designed was described in the ASCE *Transactions* of June 1900, page 469.) At the time of Mr. Fteley's retirement because of ill health, at the end of 1899, the entire project was about two-thirds completed, but only the foundation of the spillway had been placed, because that area was needed for construction tracks. Mr. Fteley's successor, apparently realizing the urgent need for more storage in the Croton watershed, decided to complete the masonry spillway crest to El. 200 for 750 ft, leaving at El. 196 only the 250-ft length of the curved part close to the main dam. It was thought that 4-ft flashboards might ultimately be placed on the section at El. 196. Because the spillway crest was raised, the roadway level on top of the main dam was also raised from El. 210 to 216.

Questions having arisen as to construction details of the main dam at the end farthest from the spillway, the Aqueduct Commissioners referred that matter to a board of experts consisting of J. J. R. Croes, then President of ASCE, a consulting engineer; Edwin F. Smith, M. ASCE, Chief Engineer, Schuykill Navigation Company; and Elnathan Sweet, M. ASCE, former State Engineer of New York. Their complete report was published in the *Engineering News* of November 28, 1901.

While this report dealt mainly with details of the main dam, it mentioned the fact that most of the spillway crest was being built at El. 200 and that 4-ft flashboards were proposed for the part at El. 196. Further on, they noted that "the masonry dam should not in any case be built higher than was originally designed. Such a change destroys the harmony and efficiency of the design, which, having been scientifically determined, should be rigidly adhered to."

Upon reading this report, Mr. Fteley replied in the *Engineering News* of December 12, 1901, as follows: "The experts object to the original plan of the dam, which they call injudiciously designed, on the grounds that no provision had been made to meet the contingency of a sudden and exceptional flow of water due to a cloudburst or to other causes. The fact is that the original design was especially devised to meet that condition. Although the surface of the reservoir, covering thousands of acres, is so large that it would have a great equalizing power, the contingency of a sudden flood causing the overtopping of the masonry dam was carefully considered."

Then later on he added: "I learn by the report of the experts that changes have recently been made, one being the raising of the crest of the masonry dam. The reasons for that change in the original plan are unknown to me. I agree that it is injudicious, as it destroys a feature which was considered very important. The calculations for the stability of the dam were made in view of the original elevation of the crest."

In spite of warnings, not only was most of the spillway crest completed on the original foundation to El. 200, but a few years later heavy cast-iron flashboard standards 8 ft apart were bolted to the entire masonry crest, and the depressed section at El. 196 was filled in between the standards with reinforced concrete slabs up to El. 200. Furthermore, two lines of 4-in. wooden flashboards up to El. 202 were dropped

View of spillway at near right shows point of demarkation between curved section near dam (foreground) and remainder built 4 ft higher. Note flashboard arrangement which raised actual spillway height 6 ft above design height. At far right, spillway cracks are being repaired by grout holes drilled through masonry and into bedrock. Photos by R. Sanchez, Dept. of Water Supply, Gas, and Electricity, City of New York.

F. B. MARSH, M. ASCE

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fixed flashboards shown by flood at Croton Dam

down the grooves in the flashboard standards for the entire 1,000 ft and the space between filled with broken stone. This was probably done around 1907 or 1908, about the time the Aqueduct Commissioners were abolished, following the establishment of the Board of Water Supply in 1905.

These flashboards seem to have been left permanently in place for 50 years. They and the reinforced concrete slabs on the El. 196 portion were removed in 1956, when serious cracks were found to have developed entirely through that part of the spillway at El. 196. Leakage through these cracks was estimated at 1½ to 2 mgd..

Repairs were made by drilling 35 vertical and inclined holes 140 to 164 ft deep, down through the spillway masonry into bedrock. These holes were then grouted in 20-ft stages under controlled pressure. It is believed that this has restored the original structural integrity of the spillway. Commissioner Ford proposes to restore the spillway in the near future to its original design by lowering the entire crest to El. 196.

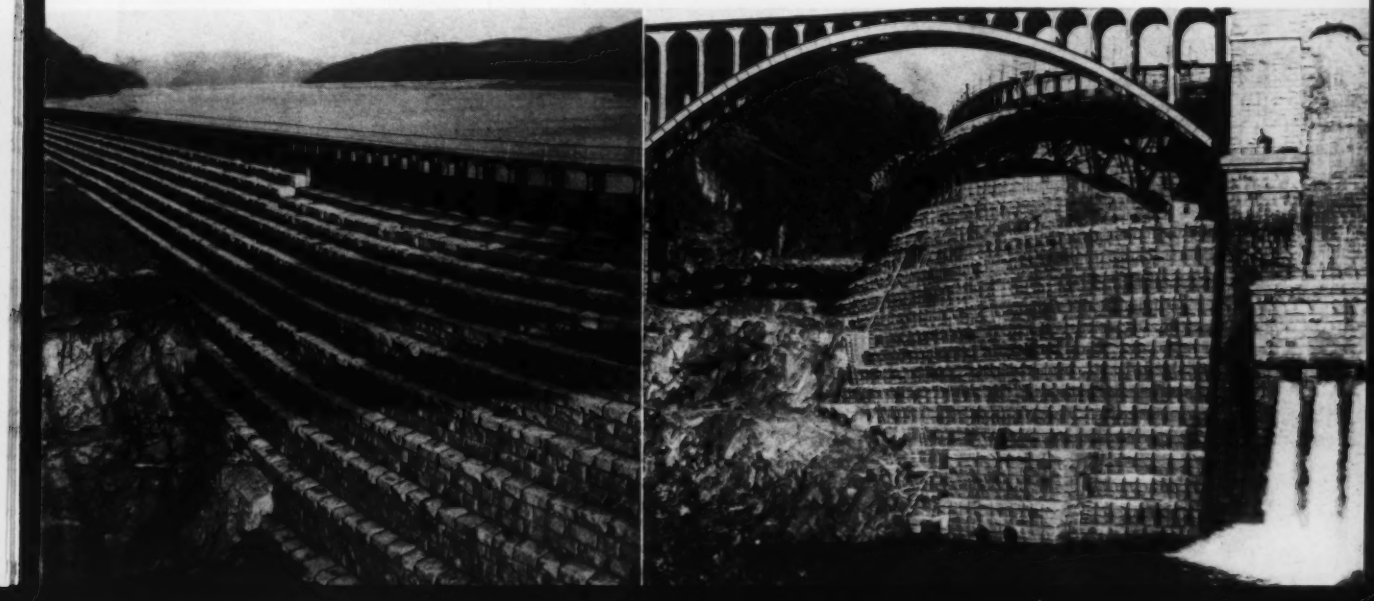
The flood flow that caused the damage followed the storm of October 14-16, 1955, with a rainfall of 10.3 in. This in turn followed the heavy rains accompanying Hurricane Diane in August, which had already practically filled the many reservoirs of the Croton system with over 100 billion gal of water. For many hours during the peak of the October flood, the masonry at the end of the spillway was subjected to very severe vibrations, apparently caused by alternate making and breaking of the vacuum beneath the heavy sheet of swiftly moving water as it passed over the flashboards.

A review of technical literature in the 14 years during which Croton Dam was under construction indicates strong differences of opinion as to the design among engineers of that day. For example, there was argument as to how much, if any, allowance should be made for ice pressure at the crest of a spillway. How much upward pressure should be assumed on the base of a dam was also widely debated.

In extenuation of the decision to raise the level of the spillway crest it may be pointed out that streamflow records had not been kept long enough at that time to satisfactorily determine possible maximum flood flows. The formulas for flood runoff then used have now been found to be rather inadequate.

It is interesting to note that John R. Freeman, M. ASCE, assumed in his historic "Report on New York's Water Supply," dated March 23, 1900, that the Croton Dam would be completed about 1902. (Actually, the last stone was laid with formal ceremonies on January 17, 1906.) He stated (page 185) that the "Plan for the stone crest of the spillway was lowered from El. 200 to El. 196 at request of Department of Public Works." Evidently it went back to El. 200 shortly thereafter.

The lesson to be learned from this experience of fifty years is that only flashboards that are collapsible under high heads should ever be placed on any masonry spillway. Also, it is a risky business to raise the crest of a masonry spillway during its construction, particularly over the objection of its designer.



Prestressed sheetpile under

W. F. SWIGER, M. ASCE, Consulting Engineer, Stone & Webster Engineering Corporation,

A modern approach to an old underpinning technique—prestressing of sheetpiling—aided builders to maintain in operation a power plant near Pittsburgh while a larger unit, with deeper foundations, was being added to it. The prestressed sheetpiling was utilized to prevent subsidence of adjacent units. Presented here are the design concepts and construction procedures developed to carry out this work successfully.

In his classic paper, "General Wedge Theory of Earth Pressure" (ASCE *Transactions,* Vol. 106, 1941, p. 68), Dr. Karl Terzaghi developed our modern concepts of the mechanics that govern earth pressure on retaining walls, sheeting, and similar structures. The effects of the movement of the wall in developing the strains that determine the pressures exerted by the soil and the development of arching, which in turn determines the pressure distribution on the wall, are today well known.

When sheeting is used to restrain the sides of an excavation, the elastic deflection of the sheeting and its supports is, in most cases, sufficient to permit the strain necessary to develop the active pressure. Consequently common engineering practice is to design the sheeting for the active pressure. As shown in Fig. 1, deflection of the sheeting, permitting strain of the soil laterally, must be accompanied by vertical settlement of the surface of the soil within the limits of the sliding wedge, which generally will have a width at the top equal to about one-half the height of the excavation.

Thus deflection of the sheeting can cause damaging settlements unless corrective measures are taken. For example, if the sheeting were to yield uniformly ½ in. laterally, subsidence vertically adjacent to it would be approximately 1 in., assuming no volume change in the soil. This effect has long been recognized, and prestressing and preloading of sheeting to minimize such motion is common practice, although such prestressing generally has been done by rules of thumb.

In 1952, the Duquesne Light Company started construction of the fourth unit in its Phillips Station on the Ohio River west of Pittsburgh. This unit, with a capacity of 156,000 kw, is much

2

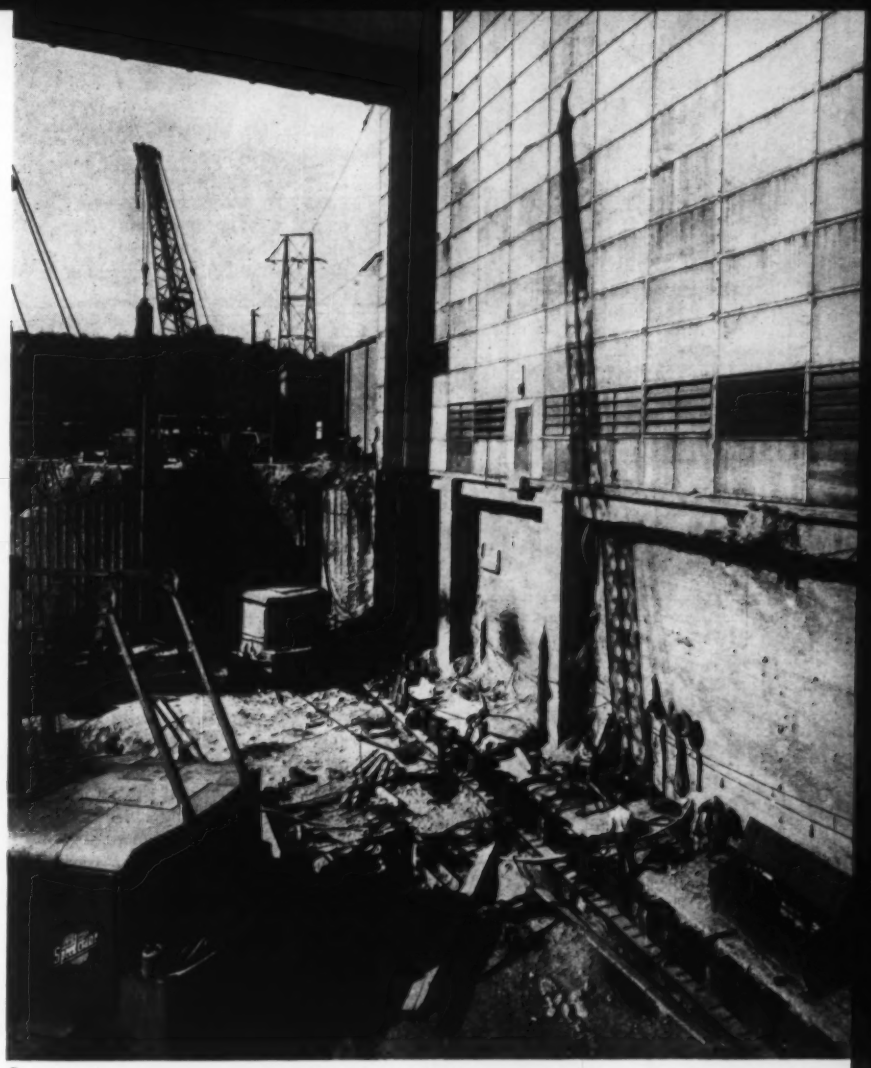
3

pinning

Boston, Mass.

larger than any of the three units previously built. The increase in capacity required that the foundations of the boiler be installed 22 ft below the level of the adjacent boiler foundations. A general plan and section through the boiler room of the fourth unit is given in Fig. 2, which indicates the founding elevations for Units 3 and 4 as well as the ground elevation adjacent to the boiler-room area.

The boiler room for Unit 3 is founded on a mat 3 ft 9 in. thick at El. 715. The average soil pressure under this mat is about 3,000 psf. There is a row of columns 9 ft 6 in. from the edge of the mat; these are relatively lightly loaded. The columns of the next row, which are only 26 ft 4 in. from the edge of the mat, carry about 3,000



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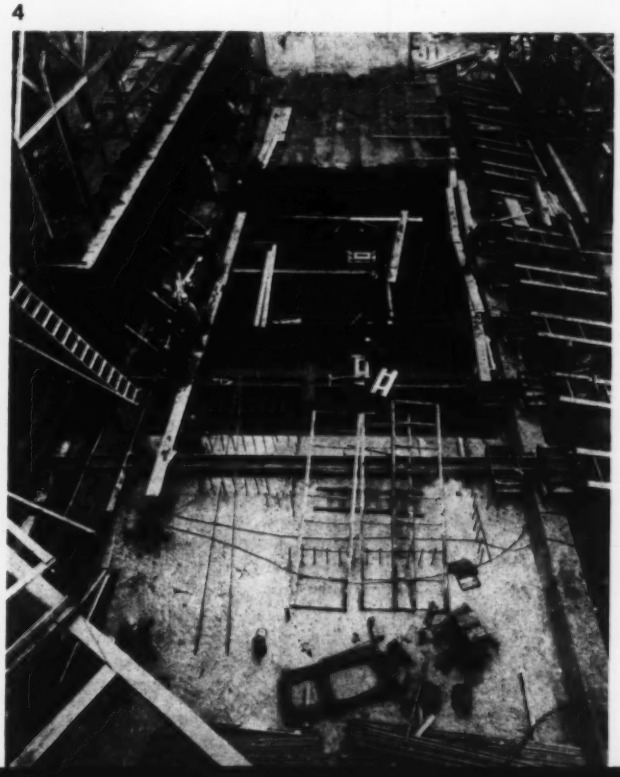
1 Sheetpiling has been driven and tied to mat of Unit 3, at right. Note cellular cofferdams in background used to support west bank of excavation.

2 Excavation for primary waler system is nearly complete, and first rakers for this system are being set.

3 Four sets of jacks are used for preloading of primary waler system, here seen at start. After raker at extreme left is properly loaded, steel shims will be inserted and jacks moved to raker No. 5. Similarly jacks from raker No. 2 will be moved to raker No. 6.

4 After load was taken by concrete mat, cast against sheetpiling, rakers for primary waler system were removed, as seen in foreground.

4



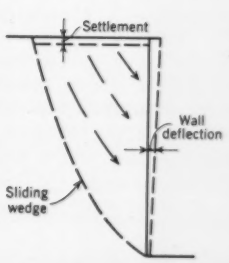


FIG. 1. Deflection of sheeting develops strains which cause vertical settlement of adjacent soil.

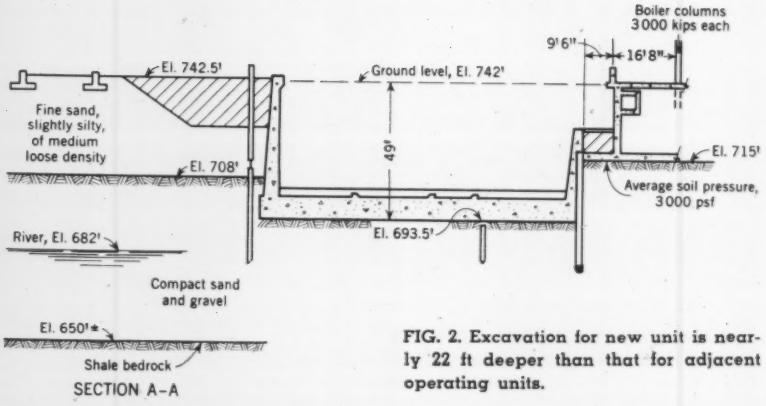


FIG. 2. Excavation for new unit is nearly 22 ft deeper than that for adjacent operating units.

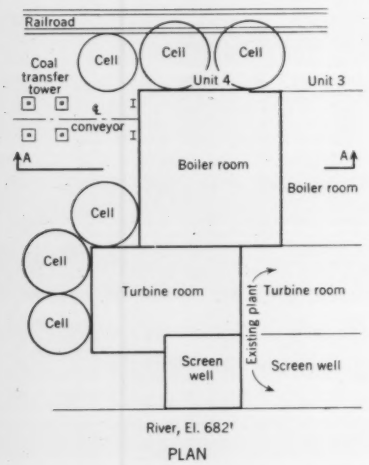
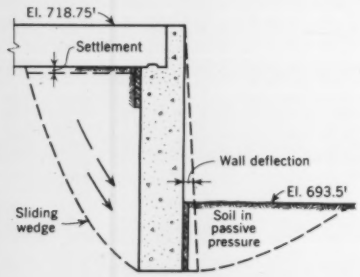


FIG. 3. (Below) Underpinning without stressing might permit damaging settlement.



kips each and are the main boiler columns for the unit. The boiler room of Unit 3 is founded on a medium fine, slightly silty sand, which extends to El. 708. This stratum is medium loose. From El. 708 down to bedrock, El. 650, there is a stratum of dense sand and gravel, which is much more rigid than the overlying sands.

Analysis indicated that to underpin the edge of the mat for Unit 3, using conventional practices, would probably cause it to crack severely. As illustrated in Fig. 3, a slight yielding of the underpinning wall from earth pressure and loss of ground, which would probably occur during underpinning, would permit some settlement of the soil wedge immediately adjacent to the underpinning wall. Thus there would be a redistribution of support under the mat. Much of the load near the edge, previously carried by a nearly uniform soil pressure, would be shifted to the outer edge of the mat as a rigid support. Since this mat was designed for uniform support, such a concentrated loading would almost certainly cause severe, and possibly damaging, cracking.

Accordingly it was necessary for the method of construction to be such as to leave the existing mat supported only on the soil, while restraining the soil in a manner that would prevent excessive settlement of the mat. It was agreed that a settlement of about ¼ in. at the edge of the mat would be permitted.

The basic scheme developed was to drive Z-section sheetpiling along the edge of the mat, supporting and restraining the soil beneath the mat by a system of walers and struts preloaded by hydraulic jacks. The initial step in installation was to excavate to the elevation of the bottom of the existing mat. From this level a line of piling was driven along the edge of the mat and tied back to the existing mat, as illustrated in Fig. 4 (*a*).

Excavation then was continued in the central part of the boiler room with the sheetpiling supported by an earth berm having a slope of one vertical on two horizontal, as shown in Fig. 4 (*b*). A transfer tower of the coal conveyor on the opposite side was also supported by sheeting and an earth berm. For construction convenience and to keep the construction joints in the mat between columns, a secondary line of 10-ft-long sheetpiling was driven to support the toe of the berm left against the boiler room of Unit 3, as in Fig. 4 (*c*). This sheetpiling was tied back at its top to the boiler-room mat of Unit 3 to limit deflection. The central part of the foundation mat was then constructed, and reaction points installed for the future jacking system.

When excavation had progressed to a level where the calculated deflection of the sheeting was about 0.2 in., a waler system supported by rakers or struts extending back to the newly constructed foundation mat was installed, as in Fig. 4 (*d*). These rakers were wedged tight against the waler, using steel wedges driven in until the sheeting was forced back to its original position.

Excavation was continued and the primary waler and raker system installed. See Fig. 4 (*e*). This system was located 3 ft above the top of the final mat. The rakers supporting this waler system were preloaded by hydraulic jacks. Using four sets of jacks and employing a leap-frog technique, the rakers were jacked in sequence to the calculated design loading. The loading was adjusted and the rakers retightened as adjacent rakers were jacked until all carried the required amount of preload. Steel shims and wedges were installed to permit moving the jacks forward. As was desired, the calculated preload on the jacking system forced the sheetpiling into the soil about 5/16 in. This loosened the temporary upper waler and raker system and facilitated its removal.

Excavation was resumed and the lower waler system placed. See Fig. 4 (*f*). The walers and rakers of the upper temporary system were reused for this set. The foundation mat was then cast against the sheetpiling, encasing the lower waler system, and the primary waler system was removed, as in Fig. 4 (*g*). Because of the mass of concrete in the foundation mat, its elastic deflections were small under the soil load, and the deflection of the sheeting on removal of the waler system was negligible. The permanent retaining wall was then constructed. This wall was cast directly against the sheetpiling, which remained permanently in place.

This work was done during the winter, and no unexpected difficulties were encountered. Observations of settlement indicated that the outside row of columns settled about 3/16 in., of which 1/8 in. occurred during driving of the sheetpiling and about 1/16 in.

during excavation for and construction of the adjacent lower foundation. There was no detectable settlement of the existing main boiler columns.

The procedure adopted was planned to prevent any significant strain in the soil mass adjoining the sheetpiling. This aim was achieved, and consequently the earth pressure against the sheeting was at or near the earth pressure at rest. Thus it was necessary to design the piling and waler systems for a lateral earth pressure coefficient of about 0.5 rather than the active pressure coefficient of about 0.25. To allow for the elastic deformation of the sheetpiling as excavation proceeded, without permitting strain of the soil mass, it was necessary for the waler points to be forced slightly into the soil. Accordingly all investigations of the sheeting as well as the design of the waler system and computations of the amount of preload to be placed on the rakers, were based on the use of a lateral earth pressure coefficient of 0.6.

Since yielding of the sheetpiling, as excavation proceeded below the primary waler system, would permit the development of some arching in the lower parts of the sliding wedge, it was probable that the soil pressure would approximate a parabolic distribution. From these considerations, the soil pressure distribution, as illustrated in Fig. 5, was used in design. The primary waler system was placed just above the top of the mat so that it could be removed. The waler systems were installed when excavation had proceeded to a depth where the calculated maximum sheeting deflection was 0.2 in.

If it is assumed that the sheetpiling deflects to a parabolic shape, it can be shown that the settlement of the surface will not exceed about 1.3 times the maximum deflection of the sheetpiling. Thus the deflection value selected corresponded to the desired limitation of settlement, or ¼ in. Walers were of a size to permit the installation of rakers spaced to permit excavation by clamshell bucket.

A similar procedure was used for the opposite bank of the excavation to protect the foundations of a large transfer tower of the coal conveyor system. Since loads there were much lighter, prestressing of the sheetpiling was done only by the use of steel wedges drawn tight.

The west edge of the excavation posed additional problems. The excavation along this edge was carried to a depth of approximately 50 ft below yard level. The yard area adjacent to the edge of the excavation was occupied by several railroad tracks and a road leading to the shops and storage areas for construction activities. These tracks had to be maintained in service, and their proximity to the edge of the excavation prohibited a sloped bank. A line of braced sheeting along this excavation would have been extremely difficult to install, because of interference with the bracing system for the sheeting along the boiler-room mat. Also, the necessary bracing system would have hampered construction operations.

The solution found was to install a row of large-diameter sheetpile cellular cofferdams, as shown in Fig. 2. These cofferdams were constructed by driving straight-web sheetpiling through the existing soil to form large circular cells along the line of the excavation. The railroad tracks were temporarily removed, where required, to permit the cofferdam installation and then put back in service over the tops of the cells.

Similar cells were used along the other sides of the excavation, except near the coal-conveyor transfer tower, where prestressed sheetpiling was used to avoid the relatively large deflections anticipated in cellular cofferdams. Observed deflections of the tops of these cells were about 7 in.

Independent circular cells were used for the cofferdams since this permitted stage driving after all the sheeting had been set and engaged, with no sheetpile driven more than 2 ft deeper than the adjacent one. Because of the heavy driving anticipated, it was believed that driving of single sheetpiles more than 2 ft at a time, or using a bulkhead type of cofferdam, would be impossible because of the possibility of driving the sheetpiles out of the interlocks. No particular difficulty was encountered in driving the sheetpiles for the cofferdams except on the first cell, where the contractor tried driving in increments of 5 ft and tore an interlock. This was repaired with tie-plates. All subsequent cells were installed by using stage driving of 1 to 2 ft at a time, and they were completed without difficulty.

Detailed designs of the sheeting and bracing systems were made by the Engineering Department of the Duquesne Light Company, with the writer serving as consultant. The construction work was carried out by the Dravo Corporation. Special credit is due these organizations. They demonstrated a keen understanding of the problem to be met and of the principles underlying its solution. The work was carried out competently and expeditiously with excellent cooperation between the designers and the builders.

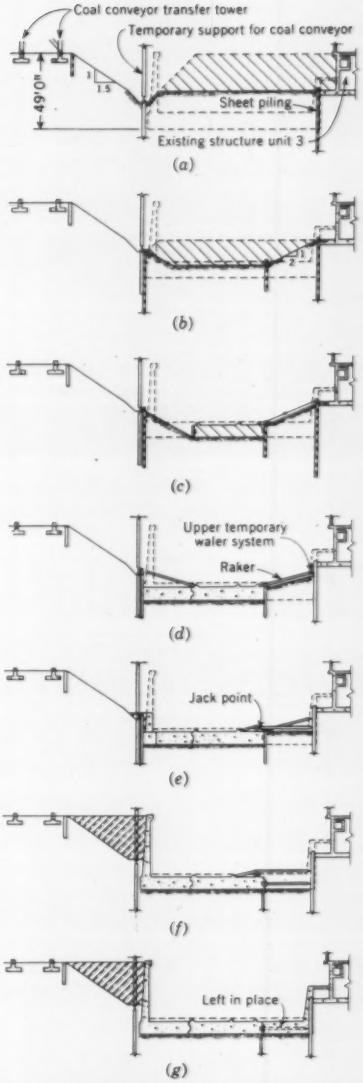


FIG. 4. Sequence of excavation, bracing, and concreting operations was planned to prevent any significant strain in soil mass adjoining sheetpiling.

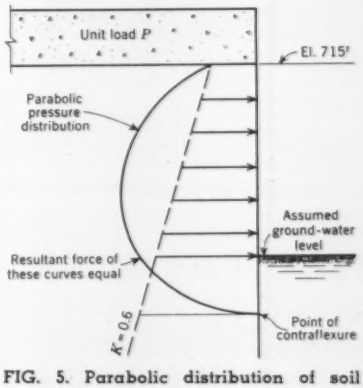
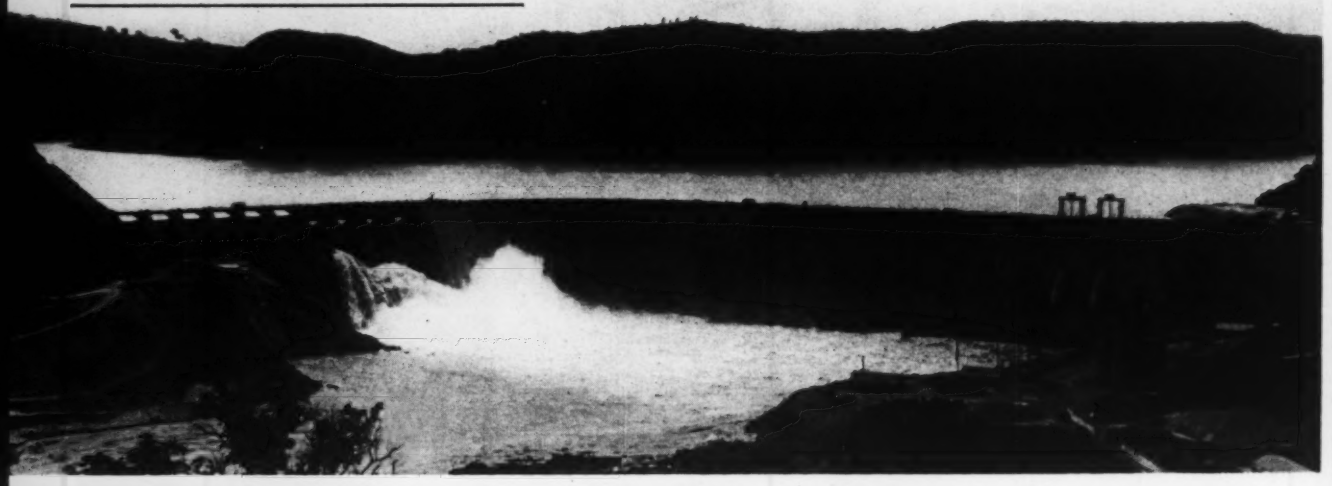


FIG. 5. Parabolic distribution of soil pressure was used in design.



First two of ten 40,000-kw units are in service at Peixoto Dam. Powerhouse structure, right, and spillway, left, are gravity dams, with arch dam between.

Unique dam completed with South America's largest construction plant

R. OLAFSEN, M. ASCE, Project Engineer, Ebasco Services Incorporated, New York, N. Y.

JOHN F. PETT, A.M. ASCE, Consulting Civil Engineer, Ebasco International Corporation, New York, N. Y.

WHAT will be one of the largest hydro developments in Latin America was officially opened on April 29, 1957, with two initial 40,000-kw units in operation. Brazil's Peixoto Hydroelectric Project is on the Rio Grande River in the State of Minas Gerais near the border of Sao Paulo.

It was designed and the construction supervised by Ebasco Services Incorporated for Ebasco International Corporation representing the Compania Paulista de Forca e Luz, a subsidiary of American & Foreign Power Company. Compania Paulista de Forca e Luz provides electric service in the north central part of the State of Sao Paulo, Brazil, where its transmission lines extend over an area roughly 290 miles long by 220 miles wide.

As at present planned, the Peixoto Project will have an ultimate installed capacity of 400,000 kw. If storage projects upstream on the Rio Grande now under study are carried out, this total capacity may ultimately be increased. In any event it is expected that installation of eight more units of 40,000 kw each will follow in quick succession.

The Rio Grande, on which the project is located, has a circuitous path due to the topography along the coastline of southern Brazil. From the coastal plain, 10 to 15 miles wide, the ground rises rapidly in a series of hills to a plateau at an elevation of some 2,300 ft. Along the edge of this plateau, which slopes inland, moisture-laden air from the South Atlantic drops heavy precipitation, which creates the Rio Grande. But this water, precipitated on the plateau a few miles from the Atlantic, flows 600 miles westward to join the Rio Parana, then into the Rio de la Plata, which passes Buenos Aires and Montevideo, and finally into the Atlantic Ocean—a total distance of over 2,000 miles. See Fig. 1.

Company engineers had explored sections of the river as early as 1929 and, in 1950, it was examined in detail by both air and ground survey methods. Of the three most advantageous sites, Peixoto, the farthest upstream, would supply the greatest amount of initial system capacity, at a lower cost per kilowatt, and in addition would provide some 1.8 million acre-ft of usable storage which would increase the capacity of any plants subsequently built downstream. In this 150-mile stretch of river there is a total drop of 2,000 ft and a total potential installed capacity of 1,500,000 kw.

Accordingly it was decided to build the Peixoto Plant, and engineering was started in August 1951. This site is 216 miles almost due north of the City of Sao Paulo and 288 miles northwest of Rio de Janeiro. Hydrological and cost studies indicated that the ultimate project capacity should be in the range of 400,000 kw, which would provide a 250 percent increase in the capacity of the Paulista system.

It was determined that the physical dimensions and weights of the components of a 40,000-kw turbine generator unit were about the maximum that could be handled conveniently by rail-

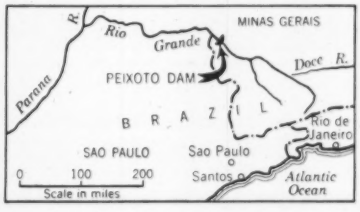


FIG. 1. Peixoto Project, serving north-central Sao Paulo, is first step in Brazil's five-year 2,000,000-kw power development program. Rio Grande, on which project is located, rises in high coastal area and flows 2,000 miles before it reaches the Atlantic via the Parana and Rio de la Plata.

road and road from the port of entry, Santos, to the job site, a distance of about 275 miles. In comparison with the largest previous units in the system (15,000 kw), the 40,000-kw unit chosen for Peixoto was a big jump.

Gravity and arch sections

Peixoto Dam consists of three main sections, as seen in Fig. 2. The gravity-type intake dam with powerhouse, 585 ft long, plus a non-overflow section 210 ft long, are on the left side of the river. The gravity-type spillway, about 525 ft long, is on the right side of the river. These two sections are connected by an arch dam with thrust blocks at each end. Including the thrust blocks, the arch dam is 615 ft long, making the total project length almost 2,000 ft. The highest point above bedrock, about 220 ft, is on the arch dam. The radius of the base circle of the arch is 255 ft, and the central angle is 105 deg at the top ring.

The project includes a powerhouse with two 40,000-kw units installed, and with provision for eight future 40,000-kw units. The main power transformers are on the powerhouse deck, and the switchyard is about 1,600 ft downstream. The total excavation was estimated at 1,750,000 cu yd, of which a substantial part was solid rock. About 500,000 cu yd of concrete was required.

The spillway section has 11 Taintor gates, each 40 by 35 ft, and one trash gate 10 by 10 ft. The discharge capacity is 350,000 cfs. Water is backed up to form a reservoir about 60 miles long, with a useful storage capacity of 1,800,000 acre-ft at 43-ft drawdown.

It was originally planned to build a curved gravity-type spillway across the deepest part of the river. However, a thorough investigation of the river bed, in the section where the water was too swift for drilling from a boat, showed that the rock bottom was 100 ft lower than anticipated, and therefore that a gravity-type structure was impracticable. For this reason the central section of the project was moved upstream to a high ledge, the gravity spillway section was replaced by an arch-dam section with two thrust blocks, and the spillway was moved onto higher ground on the right side of the arch section. The final design took the shape of a horseshoe around the upper end of an underwater canyon.

Diversion works

One of the principal construction problems was unwatering of the river bed to permit construction of the arch dam and thrust blocks and parts of the intake dam. This was accomplished by diverting the river through a tunnel driven through solid rock under the right abutment, with upstream and downstream cofferdams of rock and earth fill about 1,500 ft apart. The diversion tunnel had a diameter of 53 ft and a length of 600 ft and discharged into a canal 300 ft long emptying into the river below the lower cofferdam.

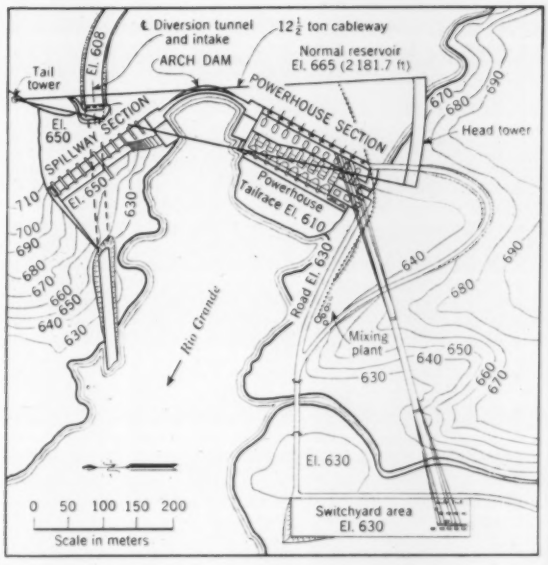


FIG. 2. Unique design of Peixoto Dam includes two gravity sections connected by arch-dam section. Highest point above bedrock, 220 ft, is in arch section. All elevations are in meters.

The upstream cofferdam, swinging across the river in an arc about 400 ft upstream from the arch-dam site, had a length of about 1,500 ft and a maximum height of about 60 ft. The downstream cofferdam, with a total length of 700 ft, had a maximum height of about 60 ft and was founded on sound rock generally overlain with a sand deposit of varying thickness.

Although the maximum recorded flood is 220,000 cfs, these diversion facilities were designed to bypass flows in the low-water season up to a maximum of 45,000 cfs, resulting in an assured working period of four months, and a probable working period of six to seven months on the arch-dam part of the project.

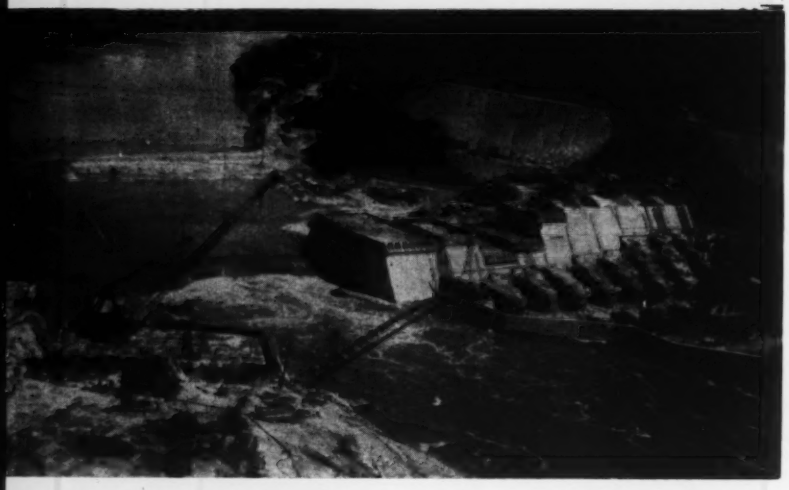
Construction was so planned that during the first diversion period all concrete for the arch in the main river channel would be raised to an elevation about 70 ft above the river bottom, and all that in the powerhouse intake dam to an elevation about 20 ft higher. This was done so that, during the high-water season, floods could be passed over the arch-dam section. Concrete would then be placed in the structures on both sides of the arch dam during the flood season, and in the arch dam after the flood season, even when the overtopped cofferdams had been washed out by the floods.

Excavation of the diversion tunnel was completed during the fall of 1954, and the upstream cofferdam was closed on June 1, 1955. Closing of the downstream cofferdam followed six days later, and unwatering started on June 13, 1955. Cleanup and excavation in the unwatered area was started immediately. The water level was lowered enough to permit thorough inspection and foundation preparation, and the first concrete in the arch dam was placed on August 6.

Powerhouse intake dam

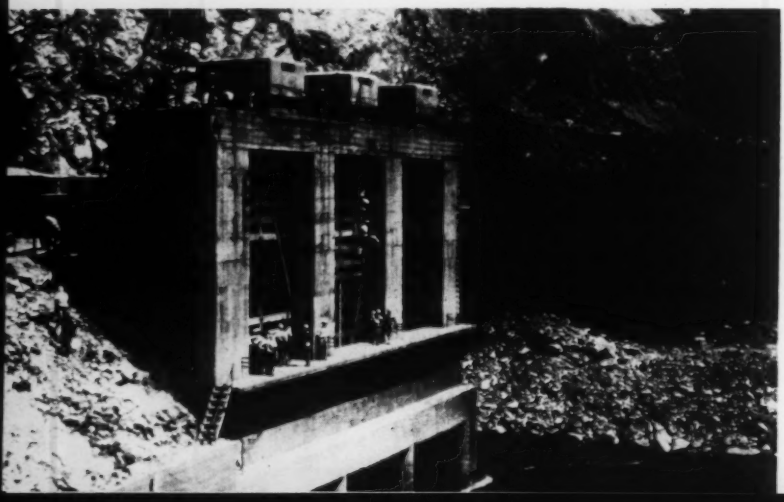
The powerhouse is a semi-outdoor station consisting of two initial units and provision for eight additional units. The spacing between units is 56 ft. The structure has two main floors in addition to a top deck and a gallery for access to draft-tubes and scroll-cases. A service bay is adjacent to Unit No. 1 on the south bank of the river.

The turbines for the first two units are Dominion Engineering Company Francis turbines with a rated capacity of 56,000 hp at a head of 155 ft. The scrollcases are of rolled steel-plate con-



Arch dam had to be raised to height of 70 ft before flood season arrived to withstand overtopping. Base is seen under construction, with upstream cofferdam beyond, in top view. Overtopping occurred six months after cofferdam was underwatered and about a month after upper photo was taken. When upstream cofferdam was breached by flood, as seen in view immediately above, work was shifted to gravity structures on both sides.

Intake to diversion tunnel contains three 50-ton gates of welded construction. Rollers carry water pressure during closure. Size of structure is indicated by workmen on platform.



struction welded together in the field and riveted to the speed rings.

For the first two units, Westinghouse Electric International Company's umbrella-type generators are used, rated 40,000 kw at 0.80 power factor and 128.6 rpm with direct-connected main and pilot exciters.

The powerhouse intake dam consists of a separate gravity structure, made up of ten individual blocks, each containing a 20-ft-dia steel penstock connecting the waterway inlet at the upstream face of the dam with the scrollcase of the turbine. At the upstream end, the inlets are protected by a continuous trash-rack structure supported on a cantilever base. Each entrance is controlled by a roller gate, operated under a maximum head of 72 ft. A short transition leads to the penstock, which passes through the dam and downward along its downstream face. A vertical curve connects the inclined part of the penstock with the horizontal part which, after a short conical transition, connects to the scrollcase entrance.

Each intake gate is operated by a hoist of 110-ton capacity on a 30-ft-high hoist structure. In the normal open position the gate is submerged and suspended in a gate slot directly over the intake opening so that closure time is held to a minimum. The hoist is operated by a control station mounted on the hoist structure, and provided with "Raise," "Lower" and "Stop" pushbuttons. In an emergency a gate can be lowered by an additional control in the powerhouse, equipped with "Lower" and "Stop" pushbuttons and indicating lights. In normal operation of an intake gate, the penstock is filled by means of the filler gate to equalize the water pressure before the gate is raised. However, the hoist capacity is sufficient to lift the gate against the full unbalanced water pressure. A gate will be removed for repair in successive steps by dogging, and removing its 20-ft-long gate stems.

An automatic emergency generator has been provided to supply power for operating the gate hoists in case of failure of the station power supply.

Spillway dam

The spillway, a gravity-type dam with an ogee overflow section, is designed for a discharge of 320,000 cfs with the reservoir at El. 2181.7. The flow is controlled by 11 Taintor gates 40 ft long by 35 ft high. The gates are operated by 80-ton hoists with sprocket chains. Stop-logs are provided for maintenance of the Taintor gates, to permit painting and seal repair without loss of reservoir storage. It is intended that the stop-logs will be placed by a crane

operating from the spillway bridge on the upstream side of the stop-log slots.

A 10 by 10-ft trash gate, installed at the end of the spillway, is lowered to pass trash. This gate weighs three tons and is operated by a 20-ton screw hoist capable of acting in both directions.

Arch dam

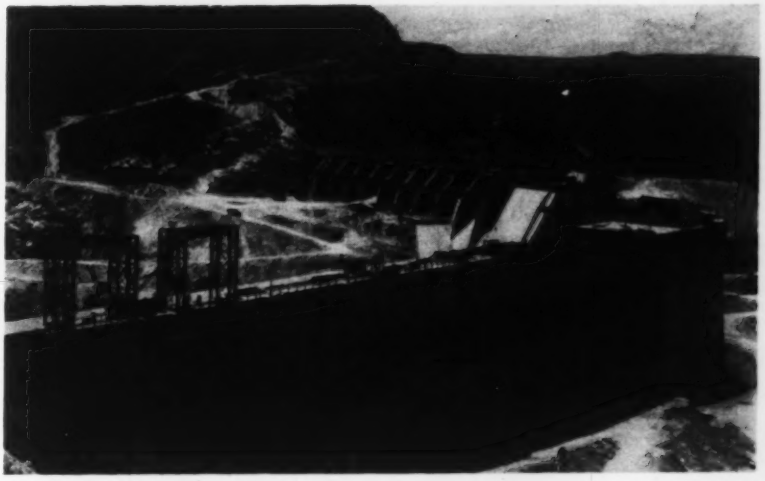
The arch dam was designed for pond level at El. 2181.7. The analysis of this arch is based on the method outlined in a Portland Cement Association paper by Alfred L. Parme, A.M. ASCE, "Arch Dams with Arches of Variable Thickness," for water-load stresses, and on that outlined in "Analysis of Arch Dams of Variable Thickness," by W. A. Perkins (ASCE *Transactions* Paper No. 2559), for temperature stresses. Allowable stresses for water load only are: maximum compression, 800 psi; maximum tension, 100 psi. Allowable stresses for water load and temperature are: maximum compression, 1,100 psi; maximum tension, 200 psi.

The thrust blocks were designed for longitudinal thrust from the arch dam perpendicular to the thrust block assumed to be resisted by the rock from El. 2129.3 down, for the north thrust block, and from El. 2050.5 down, in the south thrust block. From El. 2029.3 to El. 2191.6 in the north thrust block, the thrust block is to take the shear, the downstream component of the thrust, and the longitudinal thrust. From El. 2050.5 to El. 2191.6 in the south thrust block, the thrust block is to take the shear, the downstream component of the thrust, and the longitudinal thrust.

In the south thrust block, it is assumed that this block and four powerhouse-intake-dam blocks act as a monolithic structure, and grouting and keying of transverse joints have been carefully supervised to attain this condition.

Maximum allowable average direct shear is 60 psi; maximum allowable torsional shear is 60 psi; maximum allowable total average shear is 95 psi; and maximum allowable bearing pressure is 139 psi. Maximum headwater is at El. 2181.7; maximum tailwater is at El. 2062.0; and uplift is full headwater to full tailwater over 50 percent of the area.

In the design of the arch-dam section, it is assumed that the arch rings will take the entire water load. Initially, it was believed that the dam might extend down to El. 1935.7, and the base of the dam was not designed until the foundation was virtually uncovered. At the time this excavation was nearing completion, an inspection of the rock convinced the engineers that the basic rings would not have to be any lower than El. 1971.8. It was also decided that a concrete mat, with top at El. 1978.3 and extending downstream 56 ft maximum from the base circle of the dam, should be provided to protect the base of the dam against erosion from floods which would overflow the arch section during construction.



Powerhouse section consists of ten blocks, each containing a penstock of 20-ft diameter, 56 ft from center to center. Entrances to penstocks are protected by continuous trashrack, under construction in foreground.

The intake to the diversion tunnel has three gate openings 17 ft 9 in. wide by 36 ft high. The roller gates, of welded construction, weigh 50 tons each. Wheels were designed to carry the water pressure during gate closure. As the reservoir level rose, the sides of the gates deflected, and the water load was carried directly through bars bearing against the guides.

Largest construction plant in South America

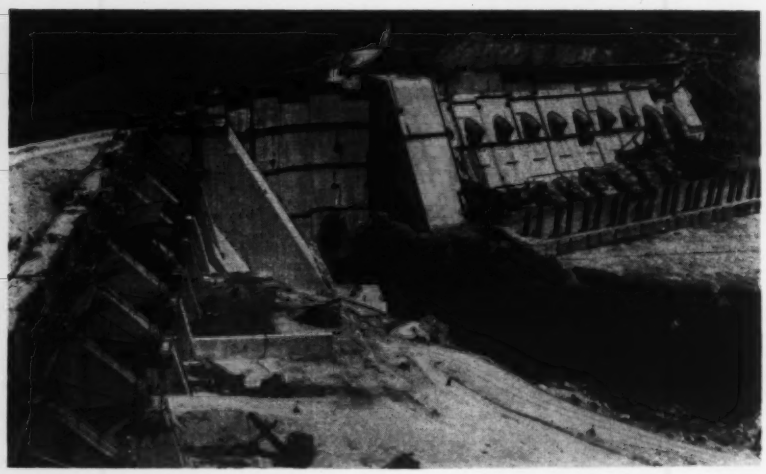
The construction plant for the project is believed to be the largest and most modern ever built in Latin America. It consisted principally of a 150-ton-per-hour aggregate plant, an automatic concrete plant equipped with three 2-cu yd mixers, and a 12½-ton cableway with movable headtower, which covered nearly all the site of the concreting operations.

To meet the concrete placing schedule before the flood season of 1955-1956, more than 100,000 cu yd of concrete was placed in the permanent structure besides that in the powerhouse cofferdam and other temporary structures. To accomplish this, all available equipment had to be brought into play. A Colby crane was placed in the spillway section, and another in the powerhouse area, plus two Bucyrus-Erie 51-B cranes, so that concrete placing could be kept going at three points at all times, thus utilizing the capacity of the mixing plant.

When the arch dam was overtopped on the 9th of December 1955, the most critical stage of construction had passed.

Rock for aggregates was hauled by truck from a quarry about one mile below the dam site. The rock passed through a 36-in. by 48-in. jaw crusher operated by a 125-hp motor. The crusher, of 150-ton-per-hour capacity, was fed by a 48-in. heavy-duty apron feeder. A 36-in. belt conveyor transported the rock from the primary crusher to the 4-ft by 10-ft heavy-duty scalping screen, after which a 30-in. belt conveyor transported the $-6 + 3$-in. aggregates to stockpile. The larger stones were fed to a 16 B Telsmith primary breaker with manganese steel head and concaves. A 30-in. belt conveyor transported the crushed rock to a 5-ft by 12-ft double-deck vibrating screen. An 18-in. belt conveyor transported the material from this screen to a 5-ft by 12-ft triple-deck vibrating screen.

From these sizing screens, belt conveyors transported the material to the $-3 + 1\frac{1}{2}$-in. stockpile, the $-1\frac{1}{2} + \frac{3}{4}$-in. stockpile, and the $-\frac{3}{4}$ + No. 4 mesh stockpile. Oversized rocks were conveyed through two Telsmith No. 36 gyrosphere crushers back to the pri-



Downstream view shows Peixoto Dam nearing completion in fall of 1956. At left is spillway dam with 11 Taintor gates, each 40 by 35 ft. In powerhouse section, two initial units, now in operation, are at far right.

mary conveyor, while the screened material left the screening plant on an 18-in. conveyor, which moved it to the $-\frac{1}{2}$ + No. 4 mesh surge pile, from which an 18-in. conveyor belt fed the 5-ft by 12-ft rod mill through a 4-ft by 12-ft double-deck vibrating screen. A belt conveyor from the screw sand classifier transported the sand to a — No. 4 mesh sand stockpile. All stockpiles were located over a pipe tunnel with a belt conveyor 24 in. wide transporting the material to the rinsing screen. Finally a 24-in. belt conveyor transported the material to the batching bin on the top floor of the concrete mixing and batching plant.

Material entering the concrete mixing and batching plant from the aggregate preparation plant was stored in separate compartments in the storage tank at the top of the plant. The aggregates were transferred to the appropriate compartment by a pivoted distributing chute. Cement was stored in a separate tank within the aggregate storage tank. From the storage tank the aggregates were passed on from the separate storage bins to the individual batchers for cobble, coarse, medium, and fine aggregates, sand, and cement on the floor below.

This floor also had the water reservoir and water batcher, and the admix reservoir and admix batcher. These batchers were operated from a control stand supplied with dial recorders. The material in the batcher to be used for a specific concrete mix was dumped into a collector cone connected to a 2-cu yd swivel chute, which distributed the material to be mixed to one of three 2-cu yd tilting mixers. The mixers emptied into a wet-batch hopper, which dumped the concrete into the Dumpcrete bodies taking it away.

Cement was hauled in from Itau, about 50 miles from the dam site, in 50-bbl Dumpcrete bodies mounted on trucks without hydraulic hoisting mechanism or additional chute sections, and dumped by an overhead electric crane into a 50-bbl truck hopper. Thence it was transported by a screw conveyor, with a screw of 10-in. diameter, handling 275 bbl per hour to the 12 × 7-in. cement-bucket elevator, traveling 270 ft per min and handling 275 bbl per hour. This elevator transported the cement to the top of three cement silos of 5,000-bbl capacity, or to the one-compartment central cement tank of 400-bbl capacity inside the octagon-shaped bin on top of the mixing plant. This bin, of 400-cu yd capacity, contained five aggregate compartments. The contents of the silos were in time dumped through a valve in the bottom of each silo into the screw conveyor for transfer to the central cement tank.

The cableway (Washington Iron Works) consisted of a radially traveling headtower with a track 600 ft long at El. 2191.6, a fixed tailtower at El. 2132.5, and a 2,000-ft span. The capacity was $12\frac{1}{2}$ tons at the hook. The headtower was 125 ft high, and the tailtower 165 ft high.

The loading point for the cableway was between 650 and 1,100 ft from the mixing plant at El. 2066.9. Concrete was transported to the cableway in two flat cars with two 2-cu yd Dumpcrete bodies on each, pulled by a locomotive. The cableway covered the two thrust blocks and the arch section, most of the powerhouse section, and the diversion intake. A reloading point for the spillway was established on the right bank at El. 2132.5.

To meet the concreting schedule designed to provide for overtopping of the arch-dam section during the wet season of 1955-1956 and tunnel closure before the wet season of 1956-1957, the cableway worked to capacity for the entire 16 months between August 1, 1955 and December 1, 1956, and the two 51 B cranes were required until April 1956 for foundation clean-up and concreting. One of these cranes worked from a fill upstream from the powerhouse section, walking onto the penstock blocks in order to place concrete in adjacent blocks, so that the cableway would be able to transport concrete to the north side of the river when the cofferdams were flooded. One Colby crane was erected on a track along the downstream face of the draft-tubes for concreting in the powerhouse area. A second Colby crane was used on spillway block No. 4 to pour concrete in the north thrust block and in spillway block No. 3.

This Colby crane was assisted by a stiff-leg derrick and a 51 B crane for placing concrete in the spillway. The Colby crane, after finishing its part of the spillway concreting, was moved to the upstream side of the arch dam, where it placed the major part of the concrete in the arch, from a track placed on a fill running along the upstream face of the arch. The stiff-leg derrick was moved to the downstream slope at the south end of the powerhouse intake dam to place final concrete, leaving a tunnel passage for the concrete loading track, which was plugged later.

Concreting was practically completed when the diversion-tunnel intake gates were closed on the 7th of November 1956. With the flow of the Rio Grande completely shut off, there was a rare opportunity to view foundation conditions at the next hydro project site about 15 miles downstream.

The water in the reservoir reached the spillway crest, and Unit No. 1 was started up, the end of December 1956.

(This article is based on two papers from ASCE's Jackson Convention, one presented by Mr. Pett and the other by Mr. Olafsen, before the Power Division session presided over by George J. Vencill, Chairman of the Division's Executive Committee.)

THE READERS WRITE

Freedom of movement for state highway engineers upheld

To THE EDITOR: Such directives as that handed down by the former Federal Highway Administrator (see March issue, pp. 94-95) are detrimental to the procurement and maintenance of adequate state highway department staffs, and do not accomplish their aim of affording such departments the opportunity of developing and retaining their staffs. The directive referred to reads as follows:

"The consultant shall not engage, on a full- or part-time or other basis during the period of this contract, any professional or technical personnel who are or have been at any time during the period of the contract in the employ of the Bureau of Public Roads or the highway organization of any State, county, or city, except regularly retired employees, without the written consent of the public employer of such person."

Not only do most professional men look upon this as a usurpation of their personal and professional freedom, but they also abhor the thoughtless misdirection of authority exercised by Mr. Volpe. The professional engineers affiliated with the Louisiana Department of Highways in Baton Rouge are unanimous in this belief, and have brought it to the attention of the proper local authorities. The result is: No clause limiting the freedom of movement of any professional or technical personnel will be included in any future contract awarded by the Louisiana Department of Highways.

We feel moreover that the existence of this clause involving personnel of highway organizations, in any contract anywhere in the United States, is detrimental to the welfare of all professional men.

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Baton Rouge, La.

Can competitive bidding provide professional services?

To THE EDITOR: The practice of inviting competitive bids for engineering services has become an increasing problem to the professional engineer during the past three years. These invitations have created quite a turmoil within the engineering societies, for they have made the engineer realize that his long-fought-for position as a professional man is being challenged. Everyone knows that competitive bids are intended for the selection of an engineer on a price basis only, regardless of what qualifying statements are included in the bid form.

Attempts to procure professional engineering services on a competitive-bid basis have developed mainly from sources connected with public agencies. They stem from a typical clause in public works laws: "Contracts or purchases which exceed one thousand dollars shall be let on a competitive-bid basis."

The governing bodies of our country provide laws to protect the people. After the laws are established, the courts interpret their meanings in actual use, and such has been the case in bidding for professional engineering services for public works. In asking for bids for professional services, public officials are overstepping the intent of the protective laws. Their interest *should* be for the people, and the courts have ruled in numerous cases that bidding for professional services is not in the public interest. Bids may be obtained from some engineers, but their professional standards are low, and it is to be suspected that their professional ability is likewise questionable. The elimination of competitive bidding by the Code of Ethics is intended to eliminate unscrupulous people from the engineering profession.

Highway commissioners, city officials, and other groups connected with the procurement of engineering services for public works tend to forget the status of the engineer as a professional man. Their request for a "sealed bid" is at the same time asking the engineer to desert the Code of Ethics established by his professional society.

It has been argued that the Code eliminates competition by not allowing competitive bidding. Competition among men capable of providing professional services should not be founded on a price basis. In evaluating the cost of engineering services, it should be kept in mind that engineering costs are a small part of the total construction cost, whereas the quality of engineering services rendered will greatly influence all other costs of construction.

Article 4 of the Code of Ethics of ASCE reads as follows:

"It shall be considered unprofessional and inconsistent with honorable and dignified bearing for any member of the American Society of Civil Engineers to invite proposals for the performance of professional engineering services or to state a price for such services in response to any such invitation where there are reasonable grounds for belief that price will be the prime consideration in the selection of the engineer."

This Article was approved by 12,443 of a total of 13,997 ballots cast. This overwhelming approval exhibits the desire of the civil engineers to provide services of a professional quality to the people.

One need only look about him to see the many structures built for society by professional engineers. Were these engineering contributions left to the unscrupulous to design and build, would they be used with the same assurance of safety and dependability that they are now? It is my view that the answer to this question is "No." If the engineers of professional status allow those of doubtful qualities to supplant them, they are not only degrading themselves but ignoring their responsibility to the public.

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A tribute to J. A. L. Waddell

To THE EDITOR: Referring to Prof. W. J. Miller's article, "Civil Engineers Can Write—History Says So," in the December issue, it seems to me that the name of the late J. A. Waddell, an Honorary Member of the Society, might well have been included.

Dr. Waddell was a prolific writer on a wide variety of engineering subjects. His knowledge of Latin appears in the title of one of his earliest texts, *De Pontibus*, a handbook on bridge design.

He delivered a number of addresses to graduating classes of engineering schools in addition to his many technical papers. Some of these were assembled in two volumes, *The Principal Professional Papers of J. A. L. Waddell*, and *Memoirs and Addresses of Twenty Years*, edited respectively by the late John Lyle Harrington and the late Frank W. Skinner, both Members of ASCE. One has but to pick at random such titles as "The Bridge Engineer and His Work," "Technical Book Writing," "Engineering Economics," "Following the Great Wall of China," and "An American Canal Between Lakes Erie and Ontario," from the latter volume, to get an idea of the breadth of his writings.

His book, *Economics of Bridge Work*, covered a phase of engineering treated, I believe, by but one other engineer, while *Bridge Engineering*, the classic of its time, was a two-volume work of some 2,300 pages, treating practically every phase of the subject, starting out with a history of the profession.

At the time of his death, when con-

siderably over eighty years old, Dr. Waddell was engaged with the late Shortridge Hardesty, Hon. M. ASCE, in the preparation of a volume which was to have been entitled "Rapid Accurate Estimating." The work was practically complete except for two chapters which were to have been finished by Mr. Hardesty, but unfortunately he never found time to do this before his recent passing.

While it is true and heartening that some "Civil Engineers Can Write," there is much room for improvement in the rank and file of the profession. Recent graduates, particularly, frequently have difficulty in avoiding ambiguous notes on drawings, not to mention the matter of good literary style. It seems only fair to state, however, that the present-day engineering school must cover a vast amount of ground in the ordinary four-year course.

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ENGINEERS' NOTEBOOK

Influence-line graphs for maximum moments in two-hinged arches

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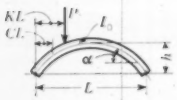


FIG. 1. Nomenclature is illustrated by diagram of two-hinged arch.

Use of influence lines to find the horizontal thrust of two-hinged arches is an excellent time saver. The article by Prof. J. Michalos, M. ASCE, entitled "Direct Design of Two-Hinged Arches of Constant Section," which appeared in the Engineers' Notebook section of the January and July 1956 issues of CIVIL ENGINEERING, has aroused considerable interest here. However, such influence-line graphs have been developed before. (See Bulletin 148, School of Engineering Research, University of Toronto, "Horizontal Thrusts for Two-Hinged Arches of Various Forms," by C. R. Young and M. W. Huggins, published in 1935.)

The idea of using influence lines can be extended further. The accompanying Figs. 2 through 4 give influence lines for maximum moments which occur in two-hinged arches of various kinds. (The nomenclature is given in Fig. 1.) These graphs can be employed to design an arch very speedily. Using the data given in the article, "Steel Arch Analyzed and Designed by Semigraphical Methods," by Milo S. Ketchum, A.M. ASCE (CIVIL ENGINEERING, August 1952, p. 31), a design can be worked out very quickly.

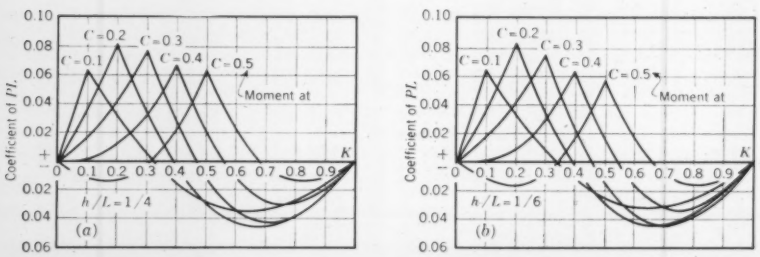


FIG. 2. Influence lines are given for moments in two-hinged circular arches of constant cross section due to vertical concentrated loads. In (a), $h/L = 1/4$; in (b) $h/L = 1/6$.

Pertinent data for the example to be given here are:

Span, 221 ft; rise, 39.07 ft; h/L, 0.177. The purlin spacing is symmetrical. Arch frames are spaced 27 ft 3 in. Dead load is 22 psf of roof surface. Ice loading is 15 psf of roof surface for partial loading.

In the example it should be carefully noted that the loading used is vertical and uniformly distributed over all or part of the span, while that used in Ketchum's article is a series of concentrated loads applied to the arch at purlin connections.

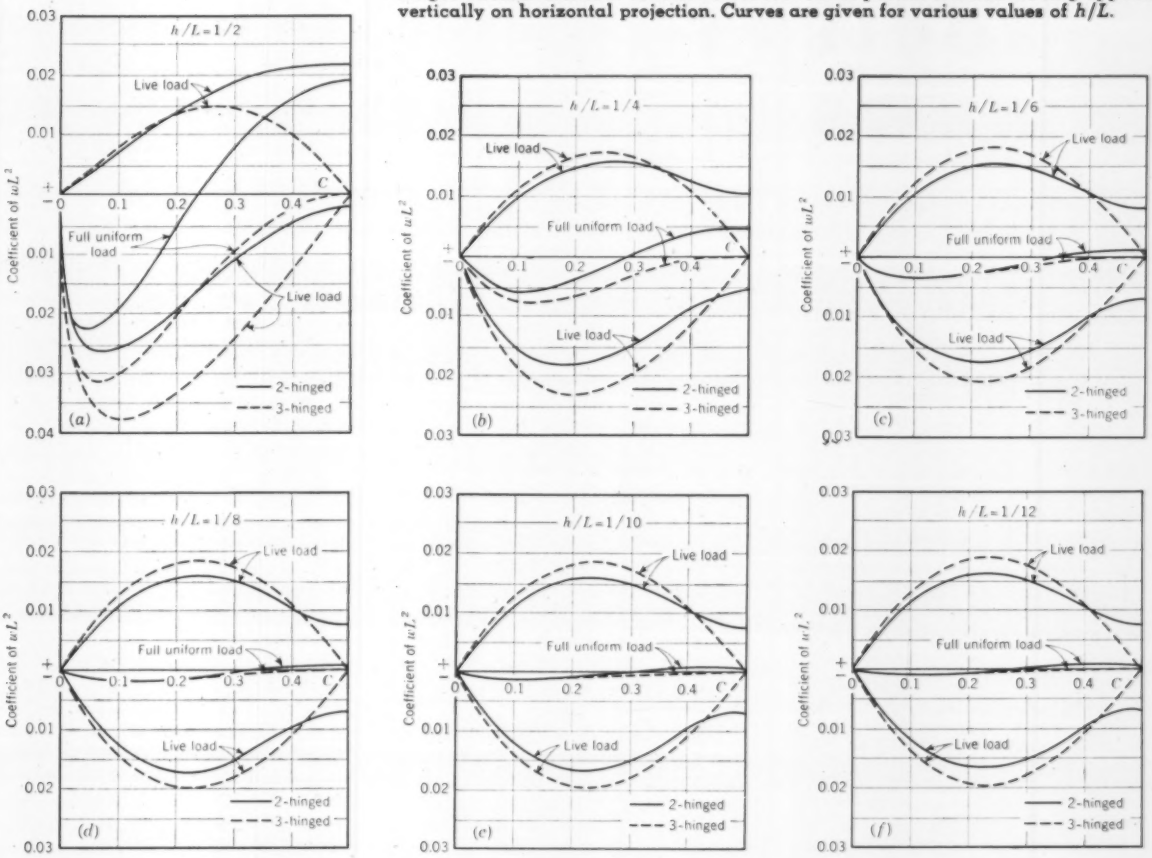
Dead load per foot of arch rib = $0.022 \times 27.25 = 0.599$, says 0.60 kips per lin ft.

Ice loading = $0.015 \times 27.25 = 0.408$, say 0.41 kips per lin ft.

From the charts, Figs. 3 (*b*) and (*c*), and interpolating, Table I is prepared.

Examination of the charts, Figs. 2 (*a*) and (*b*), shows that 60 percent of the span would be loaded to produce the live load $-ve\ M_{max}$. The moment thus found is in fair agreement with the final moment of 411 ft-kips given in Ketchum's article, p. 32. The moment

FIG. 3. Curves are given for maximum bending moment for two-hinged and three-hinged circular arches of constant cross section for partial uniform loading applied vertically on horizontal projection. Curves are given for various values of h/L.



of 432 ft-kips does not take account of stress amplification. If it is necessary to take account of this factor, it can be done either by the method described in Ketchum's article or by the method given in "The Amplification of Stress in Flexible Steel Arches," by Robert S. Rowe (ASCE Proceedings Separate No. 245, Vol. 79).

The summary given in Fig. 2 of Ketchum's article shows that the maximum moment occurs at Sta. 2 or Sta. 3 (or somewhere between these points). For Sta. 2, the fraction of the span, a, is 0.145. Using this and interpolating as before, the coefficients for live and dead loads are 0.0163 and 0.0037 respectively, giving live- and dead-load moments of 327 and 109 ft-kips and a total of 436 ft-kips, which again compares favorably.

If the live- and dead-load moment coefficients for $h/L = 1/6$ are used for $a = 0.145$, the total moment is 421 ft-kips. The extra work of interpolation is hardly worth the effort, so the nearest rise ratio graph available should be used.

A trial section can be selected using the charts and analyzed by some method similar to that given in Ketchum's article.

TABLE I. Computation based on Figs. 3 (b) and (c)

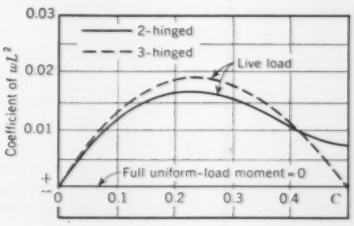
h/L	Live Load, $-wc$ M_{max}		Corresponding Ordinate for Dead-Load Moment
	Occurs at Fraction of L	Ordinate	
1/6 or 0.167	0.22	0.0175	0.0025
1/4 or 0.250	0.18	0.0180	0.0040
0.177	0.215	0.0176	0.0027

$M_{D.L.} = 0.0027 \times 0.60 \times 221^2 = 79$ ft-kips

$M_{L.L.} = 0.0176 \times 0.41 \times 221^2 = 353$ ft-kips

432 ft-kips

FIG. 4. Curves are given for maximum bending moment for two-hinged and three-hinged parabolic arches with $I = I_o \sec \alpha$ due to partial uniform loading applied vertically on horizontal projection. Curves for $I = I_o$ (constant section) are nearly identical. Note that negative live-load moments have same magnitude as positive live-load moments.



SOCIETY NEWS

Money Available for Technical Divisions, TPC Told

There is Society money available for the needs of the Technical Divisions, Francis S. Friel, Vice-President of ASCE, chairman of the Budget Committee, and Philadelphia consultant, told the Technical Procedure Conference at a meeting held in Oklahoma City, April 12 and 13. It is generally the Divisions that are more active that get more money—if they show it will be used advantageously. But any group can get its share if the members prod the officers into activity by promoting worthwhile projects. About 65 top men of the fourteen Technical Divisions attended the Conference, which was presided over by Frank A. Marston, senior Vice-President of ASCE, chairman of the Technical Procedure Committee, and member of the Boston firm of Metcalf & Eddy.

Major problems of the Technical Divisions are: (1) making Convention programs attractive and convenient; (2) selecting committee members who will work; (3) finding research projects to utilize available money; and (4) Division newsletters.

A minimum of three and preferably four or even five sessions at any Convention was recommended to the conference by Ralph E. Fadum, head of the civil engineering department at North Carolina State College and vice-chairman of the Soil Mechanics and Foundations Division. This recommendation was enthusiastically endorsed by the Structural Division with figures indicating greatly increased attendance at an extensive program.

With a view to increasing interest and attendance at Society meetings, Executive Secretary Wisely presented an idea for technical conferences to replace the present Spring and Winter Conventions. The plan is covered in more detail in the action taken by the Executive Committee at Walla Walla, Wash., reported on the following page.

Non-members of ASCE should be encouraged to participate in Division programs, said George J. Vencill, of Union Electric Co. of St. Louis and chairman of the Power Division. To get full advantage of the wealth of foreign literature available, ASCE members are requested to offer to help edit and translate this material. Willingness to help should be made known to Paul Parisi, Editor of Technical Publications, at ASCE Headquarters.

Committees and their work came in for constructive suggestions. Richard Hazen, consulting engineer of New York and chairman of the Sanitary Engineering Division, recommended serious study to be sure a committee can do a better job than an individual; that committees be set up for not more than a two-year task (the Structural Division allows three years); rotation of workers on standing committees; and picking workers, not big names, to get a job done. In discussion, speakers recommended meetings of committee members on the theory that one meeting is worth a year of letter writing. Task committee work of special importance should end in a publication or symposium.

Several Divisions feel they will be better served by having their news letters bound separately rather than at the back of the Division's Journal. One of the few formal actions of the conference was to recommend this change. This will increase the cost of all newsletters from $4,000 to $6,000 annually. It is expected that greater interest in Technical Division activities will make the change well worth while.

Outside money for research is available, according to Lowell E. Gregg, of the Kentucky Highway Department and chairman of the Committee on Research. Civil engineering is not using all of the funds that can be found. Members who have a project that will add substantially to engineering knowledge should contact the Committee on Research or ASCE Headquarters.

Head table at Oklahoma Section luncheon held during Technical Procedure Conference includes ASCE Executive Secretary William H. Wisely; Prof. Wayne Davis, secretary-treasurer of Oklahoma Section; ASCE Director William J. Hedley; Wayne D. Branick, president of Oklahoma Section; ASCE President Mason Lockwood; David Benham, senior partner, Benham Engineering Co., Oklahoma City; and ASCE Vice-President Frank Marston.

Executive Committee Meets at Walla Walla, Wash.

Walla Walla was selected for the ASCE Executive Committee Meeting, April 26 and 27, in order to permit attendance at the Pacific Northwest Conference of Local Sections on April 24 and 25. The following actions were considered to justify attention before the June meeting of the Board of Direction:

Kettering Award Rules Adopted

The Executive Committee voted to approve the Rules of Award adopted for the new Charles F. Kettering Award, which was established last October by AIEE, SAE, ASME, ASCE, AIME, and AIChE. This step was taken to expedite financing of the new prize. The committee also set the terms of ASCE's representatives on the Kettering Board of Award as follows: William R. Glidden, for the term ending in October 1959; and Carl B. Jansen, for the term ending in October 1961. The award bearing Dr. Kettering's name will be given annually "for creative accomplishments for the benefit of mankind, including discovery, invention, improvements in designs or processes within the relationships of materials and energy." Dr. Kettering received the first award at a special luncheon held in Chicago during the AIEE's 1956 fall meeting (December issue, page 76).

EUSEC Education Conference

On recommendation of President Lockwood that the status of the Society as a leader in international functions be maintained and enhanced by participation, it was voted that the Executive Secretary be authorized to represent ASCE at the September 1957 EUSEC (Europe-United States Engineering Congress) sessions in Paris.

The next EUSEC Conference will be held in New York in April 1958.

Czechoslovakian Technical Education Celebration

An invitation from the Czechoslovakian government to send a Society representative to the celebration of 250 years of technical education in that country was accepted, and Vice-President Glenn W. Holcomb was designated to attend the celebration which is being held in Prague, May 25-June 1. The Czechoslovakian Government has offered to assume the expense of sending a delegate.

Jenkins-Keogh Bill

At the request of the District 14 Council that the Society support the Jenkins-Keogh Bill, the Executive Secretary was authorized to draft an appropriate letter expressing approval of the principle of such legislation for transmittal to the House Ways and Means Committee. The bill provides for *deduction from gross income* of certain contributions toward personal retirement funds made *by self-employed persons.* (See "By-Line Washington," May issue, page 88.)

Moss-Gubser Bill

The Vicksburg Branch of the Mid-South Section has requested consideration both by ASCE and EJC of the bill by Congressmen Moss and Gubser, which provides for a separate classification and compensation schedule for scientific and professional personnel in government employment. (See "By-Line Washington," May issue, page 88.) The legislation has been endorsed by EJC. The ASCE Committee on Engineers in Civil Service was authorized to prepare a suitable resolution in support of the legislation for transmittal to the House Post Office and Civil Service Committee.

Participation in 1958 World Power Conference

In response to an invitation for ASCE to sponsor a paper for the September 1958 meeting of the World Power Congress in Montreal, the Executive Committee authorized the Power Division to arrange for a suitable contribution to the program.

Society Representation in Washington

Approval in principle was given to a general recommendation by the Executive Secretary for representation needed by the Society in Washington to handle such affairs as (1) contacts with Federal agencies concerning regulations relating to technical and professional matters; (2) employment condition of engineers in public service; and (3) contacts with legislators and Congressional committees about legislation of interest to the Society. The gist of the recommendation is that Society Headquarters attention to such matters be supplemented by a top-level Washington legal firm having access to officials at every level. A specific feasible plan is to be developed by the Executive Secretary and presented to the Executive Committee at its next meeting on June 2.

BPR Regulation Against Pirating Highway Engineers

A recent memorandum issued to BPR's district engineers (see March issue, page 94) included a recommendation that consultants in their contracts with highway departments agree to "not engage any professional or technical personnel who are or have been in the employ of the Bureau of Public Roads or the highway organization of any state, county, or city . . . without the written consent of the public employer . . ." Individual members and ASCE Local Sections have urged that ASCE oppose inclusion of such a clause in contracts for engineering on federal-aid highway projects.

The Executive Committee directed the Executive Secretary to make personal contact with BPR to determine the status of the recommended regulation. (The clause is under revision by BPR.)

[The Society's Committee on Professional Practice, at its meeting in Chicago on May 10, expressed its unalterable opposition to the clause recommended by BPR. However, the Committee considered it highly improper for consultants to employ, either on part-time or full-time basis, during the period of their contract, engineering or other technical personnel who are in the employ of a public agency as the other party to the contract.]

Technical Conferences

Executive Secretary Wisely outlined an idea for annual technical conferences, each of three-day duration, which would replace the present schedule of Conventions. Technical Divisions having related or overlapping interests would hold joint conferences. For example, the following groups of Divisions might each hold an annual meeting on a revolving geographic schedule.

Water Resources Conference
- Hydraulic Division
- Irrigation and Drainage Division
- Sanitary Engineering Division
- Power Division

Transportation Conference
- Highway Division
- Air Transport Division
- Pipeline Division
- Waterways and Harbors Division

Structural Engineering Conference
- Structural Division
- Engineering Mechanics Division
- Soil Mechanics and Foundations Division

Separate Conferences might be held by the Construction, Surveying and Map-

ping, and City Planning Divisions. The Annual Convention in October would feature Society business, Conditions of Practice sessions, engineering education, and such timely or special topics as the relation of civil engineers to nuclear energy, civil defense, and air pollution. Commercial exhibits were visualized as effective and regular features of the proposed conferences.

The Executive Secretary was directed to place the plan before the Task Committee on Convention Policy and Practice for its further consideration.

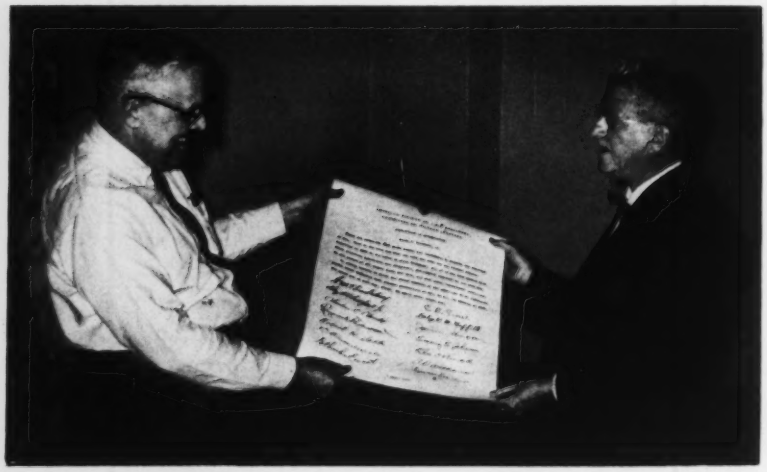
Advisory Committee on Water Policy

The final report of the EJC National Water Policy Panel was submitted to the EJC Board on April 23 and approved (see CIVIL ENGINEERING for May, pages 52-57, for the complete report). With the approval of Chairman Howson, the Executive Committee voted that the ASCE Advisory Task Committee on the Water Policy Panel be discharged with thanks and appreciation for the successful completion of the work assigned to it.

Allen P. Richmond Retires from ASCE Staff

Allen P. Richmond, Jr., Assistant to the Secretary of ASCE, has retired from the headquarters staff after almost twenty-eight years of service to the Society. Mr. Richmond was staff specialist for correspondence and visitors on educational matters, including vocational advice at all levels. For a quarter of a century he was staff contact member to the ASCE Committee on Engineering Education and to the Engineers Council for Professional Development, and for the past ten years to the Institute for International Education.

Mr. Richmond was engaged on the ASCE survey of salaries of engineering teachers and is credited with suggesting the use of point evaluation methods for college teaching positions. He conducted a survey and an evaluation of returns from 71 colleges. Under ASCE auspices he conducted job evaluations and salary surveys for the state highway departments of Arizona, Nevada and Nebraska; and five taxing agencies–Milwaukee, Los Angeles County, Louisiana State Civil Service, Maryland State Salary Standardization Board, and the Office of Personnel of Puerto Rico. He has lectured extensively, and prepared many Manuals and other ASCE publications.

Graduated from Dartmouth with a B.S. degree cum laude, and the Thayer School of Civil Engineering, at Dartmouth, with a C.E. degree, Mr. Richmond taught for nine years at the Thayer School. Prior to becoming an educator he was engaged in civil engineering enterprises in Puerto Rico and Cuba. He served in both World Wars and is a Colonel in the U. S. Army, retired.

Certificate of Appreciation is presented to Allen Richmond (right) by C. Russell Dole in behalf of the ASCE Committee on Student Chapters. The scroll says, in part, "In paying tribute to Allen the recent members of the committee whose signatures appear below symbolize many student generations as well as all the members of ASCE. God speed you on your way, Allen. We shall never forget you."

Papers Requested for 1958 Nuclear Congress

Industrializing the Atom will be the key theme for the 1958 Nuclear Congress, now definitely set for March 17-21 at the International Amphitheater in Chicago. Already sessions have been scheduled to cover economics, financing and future plans. All engineers and scientists working in the nuclear field are urged to contribute one or more papers. Abstracts are due by July 15. All papers are being handled by the individual societies involved. Thus civil engineers should submit their outlines to the Executive Secretary at ASCE Headquarters, 33 West 39th Street, New York 18, N. Y.

Sponsored by the engineering and scientific societies interested in the nuclear field, the 1958 Congress promises to be even bigger and better than the record-breaking 1957 Congress in Philadelphia. The American Institute of Chemical Engineers will manage the conference, and Engineers Joint Council will be the coordinator for the member societies.

Personnel of ASSHO-ASCE Joint Committee Chosen

Appointments to the recently authorized AASHO-ASCE Joint Committee have been announced. Harmer E. Davis, professor of civil engineering and director of the Institute of Transportation and Traffic at the University of California, will be co-chairman for ASCE. Appointed to serve with him are J. P. Buckley, A. N. Carter, Earle V. Miller, and W. A. McWilliams.

R. M. Whitton, chief engineer of the Missouri State Highway Commission, will be co-chairman for the American Association of State Highway Officials. Others named to represent the AASHO are W. A. Bugge, J. W. Johnson, G. T. McCoy, and C. R. McMillan.

ASCE Membership as of May 9, 1957

Members	9,433
Associate Members	12,682
Junior Members	17,482
Affiliates	73
Honorary Members	42
Total	39,712
(May 9, 1956	38,913)

Columbia Section Host to Pacific Northwest Conference

New Pacific Northwest Council officers, named at close of Walla Walla meeting, are (usual order, left-hand photo) Glenn H. Von Guten, chairman; Harry Drake, secretary-treasurer; and Holly A. Cornell, vice-chairman. At Conference luncheon (right-hand photo) President Mason Lockwood presents the Society's 1956 Research Prize to Vinton W. Bacon, executive secretary of Northwest Pulp and Paper Association, Tacoma. With them are Mrs. Bacon and ASCE Director E. L. Rydell.

Walla Walla, Wash., was the center of an important assembly of engineers, April 24-27, when the Columbia Section was host to the ninth annual Pacific Northwest Conference, a Local Section Conference, and a meeting of the ASCE Executive Committee (page 79). Nine Local Sections—Alaska, Columbia, Montana, Oregon, Seattle, Southern Idaho, Spokane, Tacoma, and Wyoming—took part in the four-day conference.

Columbia Basin development was the dominant theme of the two-day technical program, on April 26 and 27, which featured talks by such experts as Brig. Gen. Lewis H. Foote, division engineer for the North Pacific Division of the Corps of Engineers, at Portland, whose subject was "The Columbia River Controlled"; Marshall N. Dana, assistant to the president of the U.S. National Bank, Portland, who urged a compact type of river development; and Howard R. Stinson, former general counsel for the Bureau of Reclamation, at Boise, and Lewis A. Stanley, Oregon state engineer, at Salem, who presented the "Background for a Northwest Water Policy" from the federal and state viewpoints, respectively.

The Hanford Works atomic program figured in a paper on "Atomic Energy Developments" by James A. Travis, manager of the Hanford Works of the Atomic Energy Commission. With all the new reactors in the country, Mr. Travis said, "Hanford remains the reactor capital of the world in terms of nuclear power production and plutonium production." It has eleven reactors and a twelfth under development. While Mr. Travis' talk dealt principally with the atomic power field, he emphasized that no less attention is being given "to the tremendous potential of application in the fields of medicine and agriculture."

Society officers addressing the conference included President Mason Lockwood, whose talk was entitled "ASCE with a New Look"; Vice-President Glenn W. Holcomb, who spoke on "ASCE and the Economic Status of the Civil Engineer"; and Executive Secretary William H. Wisely, who discussed "Headquarters Services and Aims."

A hard-hat field trip to McNary Dam afforded an object lesson in effective Columbia Basin development projects. Col. Myron E. Page, who briefed the group for the tour, noted that while the original design plans envisaged only 580,000-kw generating capacity, "during recent heavy load demands the great hall of generators were operated far beyond their nameplate capacity to reach a peak of 1,250,000 kw." For hardy souls who wanted to see the initial construction stages of a similar project, there was also a tour to the site of Ice Harbor Lock and Dam on the Lower Snake.

Council officers were Leigh M. Huggins, chairman; Glenn H. Von Gunten, vice-chairman; and Clifford R. Salmen, secretary-treasurer. B. L. Smith was chairman of the conference committee. Edwin C. Franzen is president of the host Section, and Mrs. Franzen heads the Ladies Auxiliary, which set a high level of entertainment for the women.

ASCE Recognizes Student Chapter Work

President Lockwood has announced the annual awards to Student Chapters for superior work during 1956. The awards consist of 15 Certificates of Commendation and 56 Letters of Honorable Mention. Chapters at the following schools are winners of Certificates for outstanding work.

Northeastern Region
Syracuse University
Northeastern University
University of Vermont

Middle Atlantic Region
University of Cincinnati
Carnegie Institute of Technology
Fenn College

Southern Region
Virginia Military Institute
Georgia Institute of Technology
Texas Western College

North Central Region
South Dakota State College
Kansas State College
University of Notre Dame

Western Region
University of Arizona
University of Colorado
California Institute of Technology

Letters of Honorable Mention for ex-

cellent work go to Student Chapters at the following schools:

Northeastern Region
Massachusetts Institute of Technology
Rensselaer Polytechnic Institute
Norwich University
Brooklyn Polytechnic Institute
Newark College of Engineering
University of Maine
University of New Hampshire
Tufts University
Dartmouth College
Columbia University

Middle Atlantic Region
University of Delaware
Bucknell University
University of Maryland
Ohio Northern University
University of Michigan
Drexel Institute of Technology
University of Dayton
Pennsylvania State University
Johns Hopkins University
Case Institute of Technology
Swarthmore College
Michigan State University

North Central Region
University of Iowa
Missouri School of Mines and Metallurgy
University of Kentucky
University of Kansas
Iowa State College
University of Missouri
University of Arkansas
Michigan College of Mining and Technology
University of Nebraska
University of Minnesota
University of Illinois
Marquette University

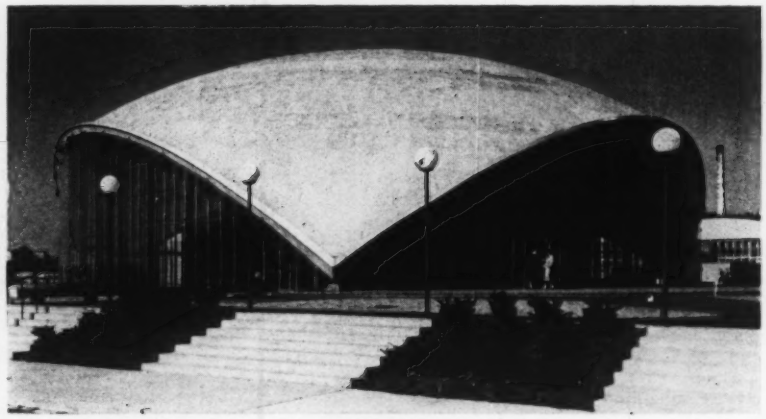
Southern Region
University of Virginia
Alabama Polytechnic Institute
Tulane University
Duke University
Texas Technological College
George Washington University
The Citadel
North Carolina State College
Virginia Polytechnic Institute
University of Alabama
Texas A & M
Clemson College

Western Region
University of Washington
Oregon State College
University of California
University of Wyoming
University of Nevada
University of Idaho
State College of Washington
University of Utah
University of Hawaii
Stanford University

Three Certificates are authorized for award by the President in each of the five geographical regions into which the present 132 Chapters, two evening divisions, and three branch Chapters are divided for administrative purposes. The number of Letters of Honorable Mention is determined by a formula devised by the Committee on Student Chapters and applied systematically but independently in each region.

Competition for these awards is keen. Leaders in the Chapters are providing constantly increasing quality of programs and better understanding of the purpose of the Chapters. Active participation in Chapter work continues to encourage participation in Local Section activities after graduation. Congratulations to the Chapter members responsible for the 1956 awards.

Hydraulics Division Conference to Be Held in Cambridge



M.I.T.'s spectacular new Kresge Auditorium will house the technical sessions set for Hydraulics Division Conference which is being held in Cambridge this summer.

With a long, hot summer in prospect, Cambridge is a likely choice for the ASCE Hydraulics Division's annual conference, set for August 26-28. It is in the center of a resort area famous for its ocean beaches, sandy or rock-ribbed, and its mountains with lakes, streams, and pine forests. For the urban minded, Boston lies just across the Charles River Yacht Basin from the M.I.T. campus, where the conference will be held. Special tours and entertainment are being planned for the ladies and children.

For the engineer of the family, technical sessions will be presented by six of the Hydraulics Division committees —Research, Design, Tidal Hydraulics, Hydrology, Floods, and Sedimentation. There will be an inspection trip, by boat, of Boston Harbor, the Boston Army Base, and Charlestown Navy Yard. A second all-day trip, at the end of the conference, will take in Plymouth, the Cape Cod Canal, and the Woods Hole Oceanographic Institution.

Expenses may be kept to a minimum by utilizing M.I.T. dormitory facilities, which will be available at $3.50 a night, single; $5.00, double; and $2.00 for children from 12 to 16. (Children under 12 cannot be accommodated in the dormitories.) College facilities will be open for all meals. Modest rates are also available at a number of convenient hotels.

The technical program and a tentative registration blank will be published later. In the meantime, persons wishing information or reservations should write to the 1957 National Conference Committee, Hydraulics Division, ASCE, Room 48-205, Massachusetts Institute of Technology, Cambridge 39, Mass.

Three Honored for Placement Work

Three engineers retiring from the San Francisco Advisory Board of the Engineering Societies Personnel Service are receiving the ESPS Certificate of Award "for valued service in the field of personnel placement of engineers." They are Walter L. Dickey, M. ASCE, former structural and civil engineer for the Bechtel Corporation; Homer G. Keesling member of the AIEE and California Civil Defense Coordinator for Utilities; and Herbert A. Sawin, member of the AIME and assistant director of sales for the Yuba Manufacturing Company.

Former Director Gardiner Posthumously Honored

John H. Gardiner, for many years district engineer for the Water Resources Branch of the U.S. Geological Survey, Tucson, Ariz., has posthumously been awarded the Certificate of Honor for Meritorious Service by the Secretary of the Interior. The citation reads in part, "for superior performance of his duties, leadership, and competent administrative service."

Mr. Gardiner, who died in Tucson on July 27, 1956, served ASCE as Director from 1945 to 1947. He had also been president of the Arizona and Mid-South Sections.

Washington Award Goes To Walker L. Cisler

This year's winner of the Washington Award is Walker L. Cisler, prominent electrical engineer and industrialist. During the war Mr. Cisler held important assignments in the War Production Board, the Office of War Utilities, and later with the Armed Forces in Europe. He is currently president and chairman of the board of the Detroit Edison Company. Mr. Cisler is cited "for outstanding and untiring service to his country and mankind by making the world a better place to live through electric power."

Presentation of the award to Mr. Cisler took place at a dinner of the Western Society of Engineers held in Chicago on April 22. Established in 1919, the Washington Award is a joint award of the four Founder Societies and the Western Society of Engineers. It is given annually for "accomplishments which preeminently promote the happiness, comfort and well-being of humanity."

Terrell Prize Awarded at District 9 Council Meeting

ASCE Past-President D. V. Terrell (left) presents award established in his honor to Milton Evans, Jr., of the Kentucky Section, during District 9 Conference. President Mason Lockwood looks on.

As usual the big feature of the District 9 Council Conference, to which the Central Ohio Section was host in Columbus, April 12 and 13, was the Terrell Award Competition for Junior Members. This year the young contestants—carefully weeded out in preliminary Local Section competitions—wrote on the subject, "How ASCE Is Preparing Me for Professional Status." Milton Evans, Jr., of the Kentucky Section, was the winner and received the Terrell Award Plaque, established a few years ago in honor of Daniel V. Terrell, Past-President of the Society.

In his fine paper Mr. Evans quoted from a talk by Past-President Needles who defined the "element of avowal as a cardinal element in true professional practice," and showed how Mr. Needles' definition helped him to a better understanding of professionalism. "By affording me the opportunity to speak on this subject," Mr. Evans said, the Society "is providing me the stimulation, associations, information, and opportunities to prepare myself for professional status."

The two-day program included panel discussions on Water Supply Problems Resulting from Supplementary Irrigation Practice, moderated by M. C. Boyer, hydraulic engineer for the Indiana Flood Control and Water Resources Commission; and on the Engineer's Role in Public Affairs, moderated by George J. Kral, Cincinnati consultant. Dr. G. Brooks Earnest, president of Fenn College, moderated a session devoted to activities of the Department of Conditions of Practice. President Mason Lockwood was featured speaker at the banquet concluding the two-day program.

Council officers were W. G. Hamlin, chairman; F. E. Schrader, vice-chairman; and C. H. Kurtz, secretary treasurer. C. B. Smith is president of the host Section.

Convention News for You

"I went to the meeting of the Society last fall at Philadelphia. The first day I was there, not a soul spoke a single word to me and I went to bed that night damning the Society for a bunch of cold-blooded, high-hatters, or worse. I saw others talking vivaciously together, but they had no use for me—I was nobody. I made up my mind to go home on the first train the next morning.

"However, in the morning I said: 'I've been at some expense to come to this meeting and I'm going to stay one more day and I'm going to test this situation out. I'm going to speak to anyone, *any one*, I don't care who it is, from the President down, that's wearing the badge, and see what happens'. And I did.

"I found the President just as willing to talk to me as anybody. I tried the Past-Presidents, and the Vice-Presidents, and the Directors; and everybody I approached was in a happy mood, ready to talk technique, or to jolly, or to discuss the trips or the weather, just as pleasantly and congenially as would my own brother. More so, in fact. Every one was on his toes, full of pep and ready to enjoy himself thoroughly. I stayed the week through and never had a better time in my life.

"Toward the end of the week I spoke to a wallflower and found him just as I had been on my first day. He said I was the first man he'd met that had spoken to him and I took him in hand. I asked, 'Want to meet the President?' and he replied, 'Do you know him?' and I said, 'Sure! Come on, let's go see him.' And we did. Later, I told the wallflower what I'd learned during the week—that my stupid time was my own fault and that when I had done my share I had a bully time."

[*Testified by a member and reported in Proceedings, ASCE, Part II, December 1927, page 4; and still news!*]

ASCE CONVENTIONS

ANNUAL CONVENTION
New York, N. Y.
Hotel Statler
October 14-18

CHICAGO CONVENTION
Chicago, Ill.
Sherman Hotel
February 24-28, 1958

PORTLAND CONVENTION
Portland, Ore.
Multnomah Hotel
June 23-27, 1958

TECHNICAL DIVISION MEETINGS

WORLD STRUCTURAL PRESTRESSED CONCRETE CONFERENCE
San Francisco, Calif.
Fairmont Hotel
July 29-August 2

HYDRAULICS CONFERENCE
Cambridge, Mass.
Mass. Inst. of Tech.
August 26-28

WATERWAYS & HARBORS CONFERENCE
Princeton, N. J.
October 18
(Part of Annual Convention program)

COUNCIL CONFERENCES

DISTRICT 7 COUNCIL
Grand Rapids, Minn.
North Central School of Agriculture
July 19-20
and
Local Section Conference
July 18-19

LOCAL SECTION MEETINGS

Illinois—Weekly luncheon meetings at the Chicago Engineers Club every Friday at 12 noon.

Sacramento—Weekly luncheon meetings at the Elks Temple every Tuesday at 12 noon.

Wisconsin—Tour of the new Marquette Cement Company plant, 745 West Canal Street, Milwaukee, followed by dinner and a program of speakers at the Stockyards Cafeteria, on June 20.

NOTES FROM THE LOCAL SECTIONS

(Copy for these columns must be received by the fifth of the month preceding date of publication)

Between meetings in Los Angeles and Oklahoma City, Executive Secretary William H. Wisely visited the **Arizona Section** which had a luncheon in his honor at the restaurant at the Phoenix Sky Harbor Airport. In the featured talk Mr. Wisely discussed Society affairs at national level, engineering ethics, and savings achieved last year in operating the headquarters office. The Section's **Phoenix Branch** has elected the following new officers: Larry Geraurd, president; Robert Welman, vice-president; James Deatherage, secretary-treasurer; and Fred Miller, junior assistant secretary-treasurer.

Aerial mapping as an important adjunct of highway planning was the theme of the featured talk at the **Central Illinois Section's** April meeting. H. L. Brantley, engineer of aerial surveys for the Illinois Division of Highways, described the work of his department since its inception in 1956. In photographing more than 2,000 miles of proposed highway routes, Mr. Brantley said, the department has found that it can save considerable money by doing the work itself instead of having it done commercially. While many problems connected with aerial mapping are still to be solved, it was evident from Mr. Brantley's talk that techniques have progressed amazingly in the past decade. President Mason Lockwood was also present and talked briefly about Society affairs.

Bartholomew J. Shine, for many years professor of structural engineering at the University of Cincinnati, was guest of honor at a recent dinner given by the **Cincinnati Section.** Professor Shine becomes professor emeritus at the end of the school year. The new Section slate, for the 1957-1958 season, consists of Ray Raneri for president; Robert H. Akers, vice-president; and Arthur C. Andrews, secretary-treasurer.

Several past-presidents of Montana Section turn out to welcome President Lockwood on recent visit to the Section—the first presidential visit since the Section was established in 1945. In first row are John Morrison, Mr. Lockwood, and C. S. Heidel. Second row shows Jack Y. Barnes, Joseph Maierle, Henry Helland, and Section President Frank Stermitz. Mr. Lockwood's trip to Montana included visits with the Billings and North Central Branches. The Section also took him on a tour of Canyon Ferry Dam and the Helena Valley Irrigation Project, Bureau of Reclamation projects currently under construction.

Cyclotherm Division, National U.S. Radiator Corp., Oswego, N. Y., increases drafting room output with Kodagraph Autopositive Film intermediates. These extremely translucent "masters" also produce sharper prints for this leading manufacturer of oil- and gas-fired steam and hot water generators.

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Photographed at head table at recent New England Council meeting, held at Worcester, Mass., are Prof. Ernest L. Spencer, chairman of Council; Ephraim A. Brest, chairman of Massachusetts Port Authority and speaker of the evening; Dean William P. Kimball, vice-chairman of Council; Frank A. Marston, ASCE Vice-President for Zone I; and Frederick H. Paulson, ASCE Director for District 2.

National Capital Section sponsors dinner meeting at Engineer Research and Development Laboratories at Fort Belvoir, Va. In this photo (left to right) are George H. Hickox, director of research at the Laboratories; George W. Howard, technical director; Maj. Gen. Emerson C. Itschner, Chief of Engineers; Section President Daniel B. Ventres; Alfred R. Golze, secretary of Section; and Maj. Gen. Charles G. Holle, Deputy Chief of Engineers for Construction. Dr. Howard headed a battery of speakers on the Fort Belvoir set-up. The others were Maj. Joseph A. Bacci, who discussed the Army Package Power Reactor; Flory A. Tamanini, whose topic was military bridges; and Harry N. Love, Jr., who spoke on the military water supply system. U. S. Army Signal photo.

The Student Chapter at the Georgia Institute of Technology was in charge of the program for the **Georgia Section's** May meeting. The program theme—"Georgia Tech Research Pays Off"—was ably presented by Student Chapter Members Gavin P. Parrish, Reginald E. Robinson, Jr., and J. Alex Little. Section President Burton J. Bell was featured speaker at a recent meeting of the **Central River Valley Branch.** His topic was the power and navigation program of the Corps of Engineers' South Atlantic Division.

Computing services available to the civil engineer were described at a recent meeting of the **Kansas Section** by Talmadge Y. Hicks, of the Service Bureau Corporation. Mr. Hicks explained how computing equipment can be used to advantage in solving civil engineering problems where repetitive calculations or large quantities of numerical data are involved. His organization offers engineering services on a contract basis.

A master plan for a proposed $69,000,000 road-building program for Jackson County, Missouri, was explained to 165 members of the **Kansas City Section** at a recent meeting by N. T. Veatch, partner in the Kansas City consulting firm of Black & Veatch. The firms of Black & Veatch and Burns & McDonnell, also of Kansas City, cooperated in making the plan. A bond issue to finance the program will be submitted to the voters this fall. In the late 1920s and early 1930s Jackson County built a system of roads ranked among the finest in the United States.

A progress report on the Pennsylvania Advanced Reactor Project—a joint project of the Pennsylvania Power and Light Company and the Westinghouse Electric Company—was presented at a recent meeting of the **Lehigh Valley Section** held in Allentown. The speaker was Harlan J. West, assistant atomic power engineer for the project, which is being carried out in Pittsburgh laboratories. The project, on which some 110 engineers, scientists, and other technical personnel of the two companies are employed, was set up to determine the technical and economic feasibility of building a large homogeneous reactor plant with an electrical output of 150,000 kw.

The ever-increasing popularity of its six technical groups—Sanitary, Hydraulics, Structural, Soil Mechanics, Transportation, and Construction—is hailed by the **Los Angeles Section.** The Sanitary Group is the oldest, having been organized as far back as 1925. The Structural, Sanitary, and Hydraulics Groups meet once a month, and the others in alternate months. The Section reports that the groups "have filled a great need." This year the Section's annual awards to "outstanding" senior civil engineering students went to William Paxton, of the University of Southern California, and Itiel Haisseman, of the California Institute of Technology. Executive Secretary Wisely attended the annual Campus Night meeting at which these student honors were presented. The program was arranged and conducted by the Junior Forum.

A flood control program for the Connecticut Valley was presented at a recent meeting of the **Maine Section's Vermont Branch** by officials of the New England Division of the Corps of Engineers. Lt. Col. Miles L. Wachendorf, assistant division engineer, and Elliot F. Childs,

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President Mason Lockwood (second from left) is guest of Philadelphia Section at its April meeting. Shown with him are ASCE Vice-President Francis S. Friel, Philadelphia; ASCE Director E. L. Durkee, Bethlehem, Pa.; and Section President Victor G. Thomassen.

chief of the Hydrology and Hydraulics Section, showed how four new earth dams fit into the flood control picture. The dams are at North Springfield, Ball Mountain, Townshend, and North Hartland.

By bus and boat **Maryland Section** members inspected the Baltimore Harbor Tunnel and approaches preceding their April dinner meeting. The $130,000,000 project, including 17.6 miles of expressway construction, is well on its way to completion. The tour emphasized the relationship of the approaches to existing streets and highways.

President Lockwood spoke informally on his experiences as President of the Society at a recent meeting of the **Mid-Missouri Section** held in Columbia. The meeting adjourned early to give members and guests a chance to visit the Open House which was being held at the University of Missouri's College of Engineering. There was a good representation of Student Chapter members from the university and the Missouri School of Mines.

Brig. Gen. Paul D. Berrigan was featured speaker at the March 18 meeting of the Vicksburg Branch of the **Mid-south Section**—a joint program with the Vicksburg Post of the Society of American Military Engineers. There was a turnout of almost 100 to hear General Berrigan, whose subject was control and use of Great Lakes waters and their interconnecting waterways—the St. Lawrence linking Lake Ontario with the Atlantic and the Calumet-Sage Canal and Illinois Waterway linking Lake Michigan with the Mississippi.

Gen. Berrigan

Engineering in Turkey—ancient and modern—was the topic of an illustrated talk highlighting the **Northwestern Section's** April program. The speaker was George Loughland, who has just returned from Turkey where he was consultant to the Turkish Government on the installation and operation of hydroelectric plants. The Section's Soils Committee recently sponsored another in its annual series of successful Soils Conferences. On this year's roster of speakers were Charles Foster, chief of the Flexible Pavement Branch of the Corps of Engineers, Vicksburg; S. E. Wiley, supervising engineer for the Illinois Division of Highways, Springfield; and Edward E. White, executive vice-president of Spencer, White & Prentice, New York.

The pros and cons of collective bargaining were thoroughly aired at a recent **Oregon Section** meeting by a large percentage of the 65 members present. It was the general consensus that employers should strive to recognize and pay for ability and experience; trust their employees; make tasks more interesting; provide desirable working conditions; provide competent supervisors and coworkers; and promote additional education. For the employee to reach his goal, he must like his position; give top performance; prove his qualifications; inspire others; accept responsibility; and recognize his employer's problems. John T. Merrifield opened the controversial discussion with an outline that took into account the problems of professionalism and the rise of unions.

In a featured talk at a recent joint meeting of the **Pittsburgh Section** and the Engineers Society of Western Pennsylvania, A. C. Ackenheil, Jr., professor of civil engineering at the University of Pittsburgh, developed the subject of land slides in the Pittsburgh area. By means of color photos taken locally, Dr. Ackenheil showed the various types of geological structures, natural and man-made, in which slides are likely to occur.

An award-winning color film telling the story of laying a new transatlantic

Members of University of Hawaii Student Chapter (in background) visit bridge construction site on field trip sponsored by Territorial Highway Department. In foreground (in usual order) are Arthur N. L. Chiu, assistant professor of civil engineering; Linton E. Grinter, Carnegie Visiting Professor of Engineering; and Owen Miayamoto, chief hydraulics engineer for the Highway Department. Dr. Grinter is visiting professor at the university this semester during its fiftieth anniversary celebration, while on leave from his post as dean of the University of Florida Graduate School.

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telephone cable was shown at a recent meeting of the **St. Louis Section.** The film, presented by courtesy of the Bell Telephone Company, showed how the cooperation of the United States, Canada, and Great Britain was essential to licking the many problems involved in undersea communication.

J. Douglass Locke, executive secretary of the California State Board of Registration for Civil and Professional Engineers, headed a panel of Board and staff members appearing at a recent **San Diego Section** meeting. The panel took part in an extensive question-and-answer period. The program also included a prize-winning paper on prestressed concrete read by **Hans Dahlke,** winner of the San Diego State College student paper competition. Presentation of Mr. Dahlke's prize, a check for $25, was another program feature.

Executive Secretary William H. Wisely was guest of honor and featured speaker at April meeting of Los Angeles Section's Santa Barbara-Ventura Branch. A tour of the Construction Battalion Center and U. S. Navy Civil Engineering Research and Evaluation Laboratory preceded the meeting. Enjoying luncheon at the Construction Battalion Center are (clockwise, starting at near end of table): J. A. Bishop; Lt. Comdr. T. H. Cushman; Branch President J. E. Sheehy; Comdr. C. J. Merdinger; Capt. E. J. Peltier; S. L. Bugg, vice-president of Branch; Julian Hinds; Capt. F. T. Pritchard; George Conahey, Branch Secretary; V. M. Freeman; Dr. W. S. Simpson; Mr. Wisely; A. C. Hardison; C. W. Petit; and Capt. R. C. Jensen. Mr. Wisely's topic was "ASCE, Its Activities and Goals."

San Francisco Section members were urged "to take an active part in civic and state affairs, even to seek and hold public office if the occasion demands," in the featured talk at the April meeting. The speaker was George D. Clyde, a practicing civil engineer and educator before he became governor of Utah in January. "The engineer is not a dreaming theorist, but a man of energy and action," Governor Clyde said. He emphasized the "particular need for the engineer to participate more fully in government." The governor is a member of the Society.

To attain true professional status, all branches of engineering must work together more closely, President Mason Lockwood told a recent **Spokane Section** meeting held in his honor. Mr. Lockwood does not believe real unity can be obtained until all national leaders firmly believe in the need for it and demand it. As a first step towards greater unity, as Mr. Lockwood sees it, there will be a merger of the Engineers Joint Council and the Engineers Council for Professional Development, which have almost identical aims.

James R. Swanson is filling out the year as president of the **Tri-City Section.** He succeeds C. H. Welker who has left the Section to live in Chicago. George F. Bishop, assistant chief bridge engineer of J. K. Knoerle and Associates, Chicago, recently spoke on his firm's problems in meeting steel shortages in designing bridges for the Illinois Toll Road Authority. After detailed studies on prestressed beams and planks, it was decided construction schedules could be met by using prestressed construction for 235 bridges. At another meeting C. C. Bolsinger, district manager of the Northwestern Bell Telephone Co., spoke on future possibilities in the field of communications.

William Robinson (center), district engineer for the New York State Department of Public Works, accepts Syracuse Section's First Annual Meritorious award given to an outstanding individual in the field of civil engineering in the Syracuse area. Viewed at the Section's second annual dinner-dance on April 27 are (left to right) Luther E. Cliffe, president of Section's St. Lawrence Branch; Carey H. Brown, ASCE Director for District 3; Mr. Robinson; A. S. Wikstrom, who presented the award; and Section President Bernard Dawson. The dinner dance, which was attended by 175, helped observe the Section's 33rd anniversary.

Lloyd D. Knapp, member of the **Wisconsin Section** and former ASCE Director for District 7, has been named 1956 Engineer of the Year by the Engineers Society of Milwaukee "in recognition of distinguished service to the engineering profession, to the community, and to the nation." Mr. Knapp was cited at a recent annual banquet of the joint engineering societies. Mr. Knapp has been city engineer of Milwaukee since 1950 and is now commissioner of public works.

BY-LINE WASHINGTON . . . . .

The $50-billion federal-aid highway program continues to jump in and out of the headlines. Alleged right-of-way manipulations in Indiana have provoked the Federal Highway Administrator here to suspend all federal aid for right of way to the state. This is potentially one of the most scandalous phases of the huge public works program. An estimated 730,000 parcels of land must be acquired for the National Interstate System, costing an estimated $5 billion. Because the state highway departments are pushing ahead quickly to grab land before costs go up, and because personnel are frequently inexperienced, occasional mistakes and cases of right-of-way fraud occur.

It is probable that rapid acquisition of land will result in lower overall cost, despite errors. The U. S. will aid in checking irregularities as it is supplying 90 percent of the funds. Senator Albert Gore, chairman of the Senate Subcommittee on Roads, has two investigators in Indiana under instructions to probe every facet of the federal government's interest in the case. At least two other Congressional committees expressed a desire to look into the problem.

* * *

The Tennessee Valley Authority would be permitted to raise $750 million over the next five years for new construction and expansion of its power plants in several proposals introduced this session. They would grant TVA the right to sell bonds for future construction needs, instead of relying upon specific Congressional appropriations for individual projects. The Administration, which is supporting the idea, has lined up a number of influential backers.

Such a move would permit orderly programming of needed projects, TVA points out, impossible under the present project-by-project arrangement. Hearings will be held this month to determine a compromise between various measures before the Senate and House Public Works Committees.

One of the controversial issues raised by the same bills when first introduced in 1955 affects civil engineers directly. TVA has again asked for authority to provide the engineering for design and construction of not only its own plants, but facilities in which it would have a "financial interest." The Authority's power manager, G. O. Wessenauer, explained the corporation's position at that time in this way:

"The kind of arrangement that I am contemplating—and I think it is a more likely one—is that someone contemplates building a plant for the express purpose of supplying power to the TVA system. It would probably not be built on the basis of TVA's paying a fixed dollar amount, or fixed rate for the power, but more likely on a basis of TVA's paying amounts that will cover the cost of building the plant, by covering the carrying charges on the plant. Under such an arrangement, the nature of the plant and the engineering characteristics of it would be a very important element in determining what the power might cost TVA."

Senator R. L. Hruska, in debating the subject, noted that TVA staff engineers are not subject to state engineering regulations. "When you are buying the output of a plant and use that as a vehicle for saying that you are sufficiently interested in it so you can override and in effect nullify state laws which govern engineers and the practice of engineering, it seems to me you are getting on tenuous ground," he said. There are plenty of independent engineers available to provide such services, he declared.

The TVA scheme has produced $1½ billion worth of electric power construction already, and growth in its service area indicates a need for 15 percent expansion each year.

* * *

Civil engineers who have devoted their time and skills to the design and construction of flood control projects may glean some indication of their contribution from a Congressional committee study just published. In a brief report, "Costs and Benefits of the Flood Control Program," the House Committee on Public Works reveals that every annual dollar cost of such facilities now in operation produces benefits worth three times as much.

Some 391 projects placed in full or partial operation with federal aid, as of June 1954, have prevented flood damages totalling $7.3 billion. That is already twice the total federal appropriation for their construction. Authorized projects now underway will prevent annual flood damages of about $200 million.

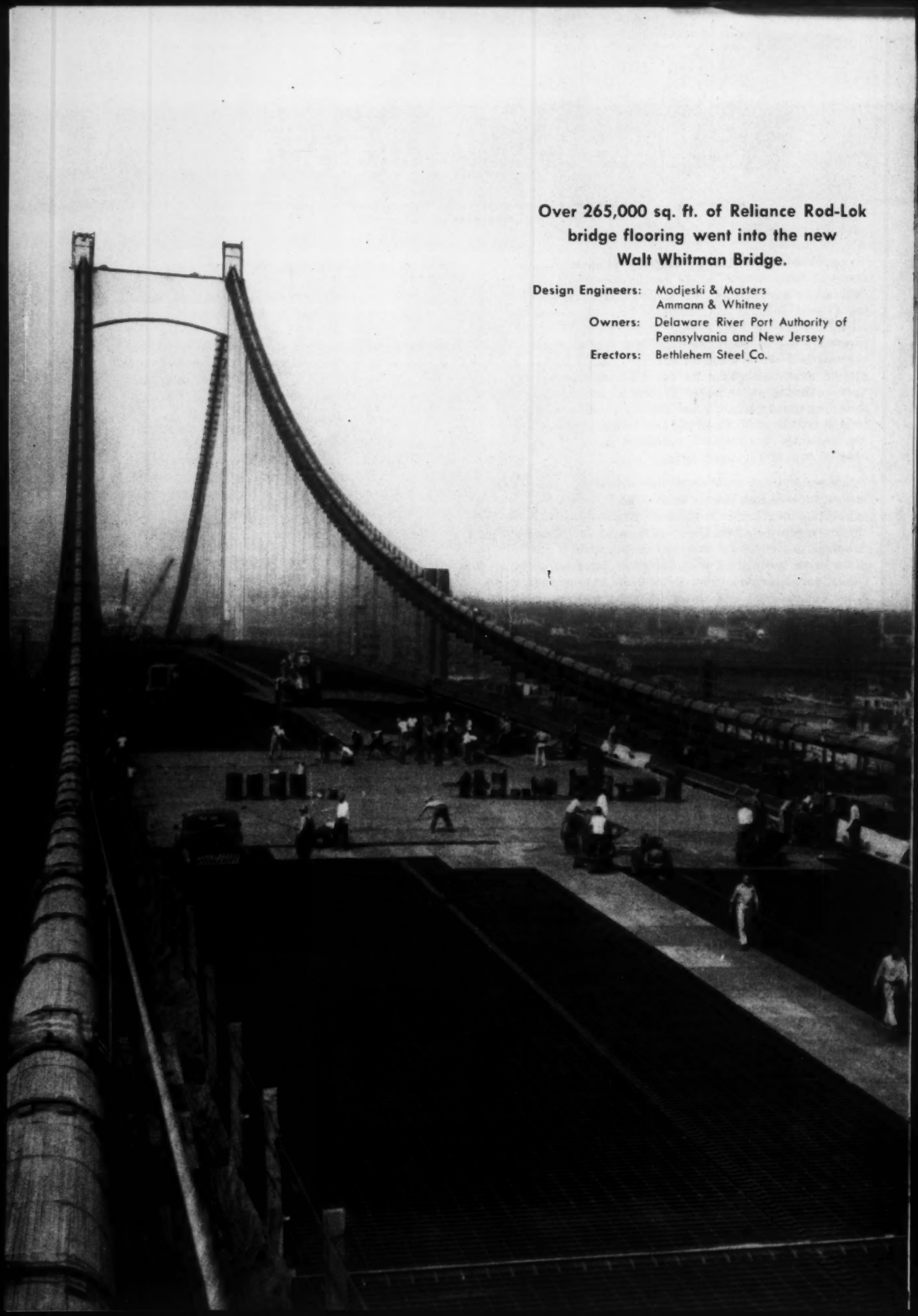
* * *

Modern methods of engineering will be one of the prime concerns of a new division in the Bureau of Public Roads. The new unit will promote the use of aerial photography and electronic computation in highway work.

* * *

New job classification guides for engineers were established last month by the federal United States Civil Service Commission. Their object: Better utilization of engineering manpower. The federal personnel office hopes that by careful shifting of some technical duties to trained technicians, the 45,000 professional engineers now at work for Uncle Sam will be free to concentrate more on purely professional assignments. (There are about 15,000 engineering aides and technicians supporting this corps of professional engineers.)

Reclassification of many functions now being handled by engineers will accomplish two results, Civil Service believes. It will further segregate the highly professional engineering assignments from the routine chores, thus enhancing the high standards of the engineering profession, and it will open promotion possibilities in the higher grades to some engineers.



Over 265,000 sq. ft. of Reliance Rod-Lok bridge flooring went into the new Walt Whitman Bridge.

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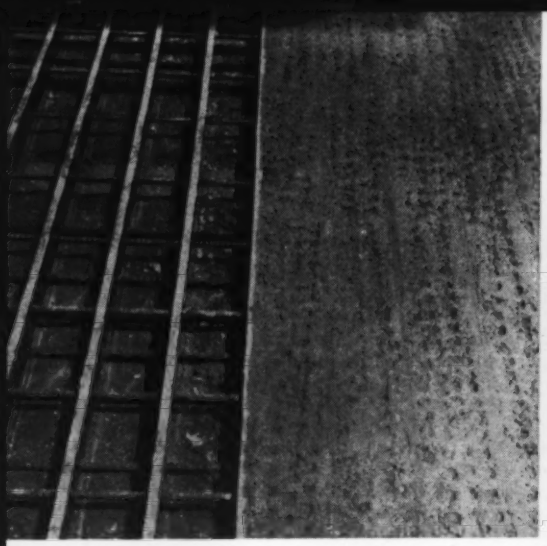
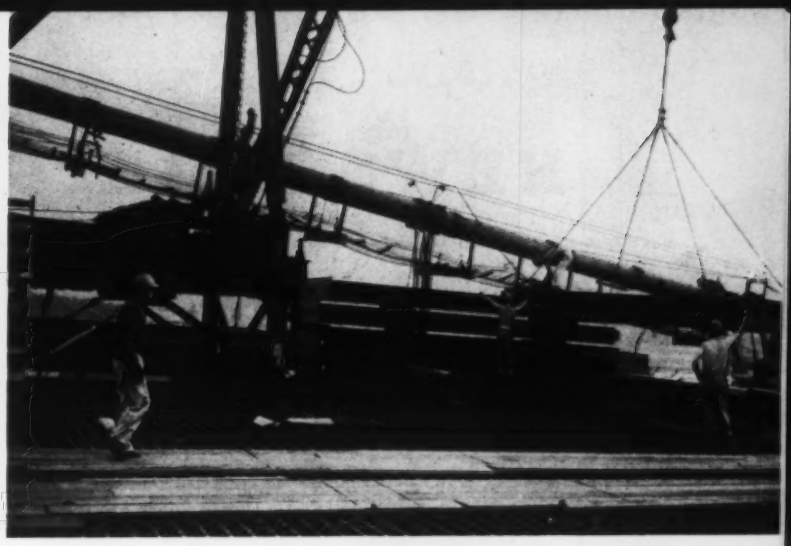


Built-in pans serve as forms for concrete, eliminating costly and hazardous form-building operation.



Using one boom, a welding crew could erect up to 9200 sq. ft. of flooring per day.

Reliance Rod-Lok Lightweight Deck Speeds Erection Time, Reduces Deadload and Lowers Final Cost of Walt Whitman Bridge

Over 265,000 sq. ft. of Reliance Rod-Lok flooring was used in the construction of the Walt Whitman bridge over the Delaware River connecting Glouster, N. J. and Philadelphia. The flooring used was the standard 5″ Rod-Lok with 7″ I-beam spacing, with slight modification in the form pan and in the cross-bar spacing. The extremely low weight of the flooring (16 lb./sq. ft.) saved many tons of steel in the superstructure, reducing both the initial cost of the bridge and the interest charges.

The Rod-Lok flooring includes built-in forms which eliminate costly and hazardous form-building operations. Months of construction time were saved, bringing in the toll revenues sooner. Large size of panels made laying fast—over 9200 sq. ft. per day could be erected by a crew of welders and a boom.

Rod-Lok is available in both 5″ and 4¼″ I-beam sizes with various beam spacings to meet any requirement. Safe span lengths are exceptionally long, as the table indicates. Time and labor saving concrete form pans are standard in all sizes.

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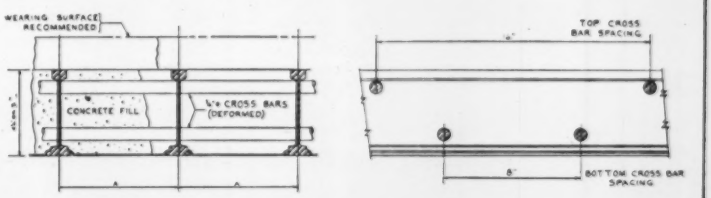
		Concrete	Tension Steel				Concrete	Tension Steel		
6	66.0	57.2	3.46	8′-1¼″	7	75.8	77.0	4.72	10′-9″	$f_c' = 3000\ \#/in^2$ $f_c = 1200\ \#/in^2$ Max. $f_s = 18{,}000\ \#/in^2$ $n = ES/EC = 10$
7	64.6	52.0	2.96	6′-7½″	8	74.5	71.1	4.14	9′-3″	
8	63.5	48.3	2.61	5′-4½″	9	73.9	66.9	3.73	8′-0″	SPECS: 1953 A.A.S.H.O. H20-516 or H20
9	63.2	45.0	2.33	4′-6½″	10	73.1	63.1	3.40	7′-0″	

The values shown are effective spans; add ½ stringer flange width to obtain stringer spacing.



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NEWS BRIEFS . . .

Ground Broken for Great Lakes Deepening Project

A $136,000,000 Corps of Engineers project for deepening the Great Lakes Connecting Channels was officially started late in May in groundbreaking ceremonies highlighted by setting off a blast in Amherstburg Channel, 18 miles south of Detroit. The Amherstburg Channel portion of the job, which will cost $23,000,000, initiates a five-year deepening program that will permit the entire 1,200-mile Great Lakes waterway to accommodate deep-draft vessels carrying maximum cargo.

Depths now available in the Connecting Channels will not permit the larger, modern vessels to load to maximum draft except at abnormally high lake stages. It is estimated that each inch of added draft will increase the carrying capacity of a modern ore vessel by about 4,400 tons per season. The projected program, which will be carried out without interrupting marine traffic, includes channel work in the Detroit, St. Clair, and St. Marys rivers and Lake St. Clair.

The Detroit District of the Corps of Engineers will handle the modernizing program, with Brig. Gen. Paul D. Berrigan, M. ASCE, division engineer for the North Central Division, in charge of the overall program. The contracting officer is District Engineer Peter C. Hyzer. Colonel Hyzer is co-author of a Buffalo Convention paper on the scheduling of the available specialized construction equipment, which will be published in a forthcoming issue.

Brazil Pushes Plans for New Capital

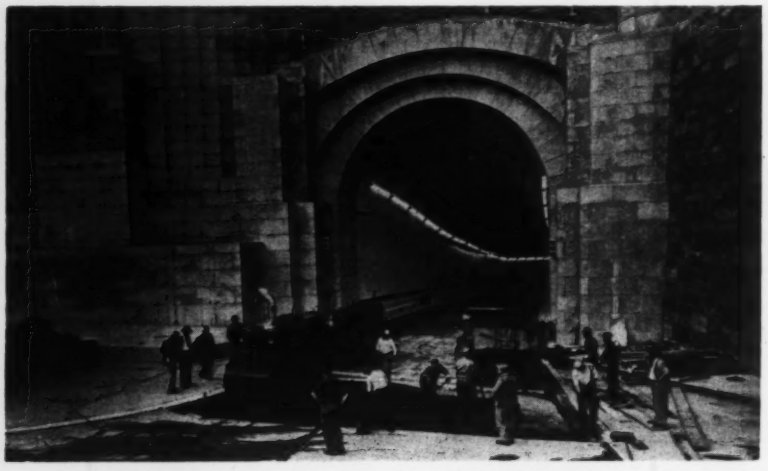
Brazil is currently pushing its long-discussed plan for moving the capital from Rio de Janeiro several hundred miles inland to the state of Goias. The capital, which will be called Brasilia, will ultimately be relocated in a recently created 2,000-sq mile Federal District. The nearest paved highway is at Anapolis (about 80 miles away) and the nearest railroad, the Central de Brasil line at Pirapera.

Construction of the many facilities needed will be under the Companhia Urbanizadora de Nova Capital de Brazil, a government-owned agency. Bids have already been received for construction of an asphalt-paved highway from Anapolis to Brasilia, and a second paved highway from Belo Horizonte (about 160 miles away) is tentatively planned. The Central de Brasil expects to extend its line from Pirapera, and the Paulista Railway may build a direct line from Sao Paulo to Brasilia. Initial construction planned by the government company includes a water supply and sewerage system (to cost an estimated $7,800,000); fourteen public office and government buildings (including a residence for the president, to be completed in 1958); about 3,000 cooperative-type apartment units; and a two-runway airport (one paved runway is already being built). Oscar Niemeyer, one of Brazil's best known architects, has been engaged to design the public buildings.

All contracts will be on a cost-plus basis, with the Companhia Urbanizadora determining what firms will be permitted to bid and what bids will be selected. The company has received federal funds to cover initial expenses, and expects to finance the major part of construction costs by sale of land in Brasilia to private companies.

Despite these detailed plans, it is said that transfer of the capital is not yet completely certain. Some civic leaders in Rio de Janeiro and Sao Paulo are in opposition to the move, and economists fear the project will further aggravate inflation. The project has the enthusiastic backing of the president of Brazil.

Third Tube of Lincoln Tunnel Is Open



Lincoln Tunnel capacity has been increased 50 percent by a Third Tube, which was opened to traffic this May. This is a view of the final phase of the work—paving the 8,000-ft, two-lane roadway with a 4½-in. asphaltic concrete wearing course bonded to the reinforced concrete roadway base. The week-long paving operation was done between the hours of 6 p.m. and 6 a.m. by the Standard Bitulithic Company, of Newark, N. J., under a $46,978 contract. Ground was broken for the project in September 1952. Cost of the entire installation was $100,000,000.

Daily Output of Steel Rises in First Quarter

On a daily basis, steel production was higher in the first quarter of this year than in the comparable period of 1956. However, the total output of 31,586,968 tons was slightly lower than in the day-longer first quarter of 1956, according to the American Iron and Steel Institute. The amount of decline this quarter was about 285,000 tons of ingots and steel for castings, or less than one day's output. The daily average was 350,966 tons, compared with an average of 350,242 tons per day for the first quarter of 1956. During the recently completed quarter the nation's steel-making furnaces were operated at 96 percent of present annual capacity (133,459,150 tons).

Southern California Builds for More Water

This June work will start on one of the final projects involved in bringing the Metropolitan Water District's Colorado River Aqueduct to full capacity. The work, consisting of the fabrication and installation of 47 inverted siphons along a 183-mile segment of the aqueduct, will help bring the water supply line to its planned, full capacity of more than a billion gallons a day. The aqueduct is now delivering about half that amount to fast-growing Southern California. In the initial development of the Colorado River supply, which was completed in 1941, most of the siphons were designed for a second barrel.

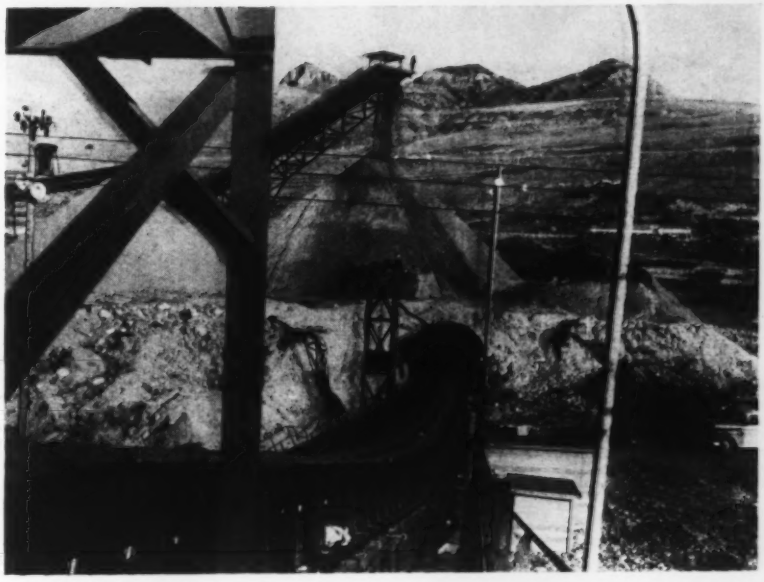
The pipe fabrication and installation work on the second barrel of the siphons will be performed by the American Pipe and Construction Company under two contracts totaling nearly $16,000,000. With one minor exception, all siphons in the first barrel of the aqueduct were constructed of cast-in-place reinforced concrete pipe. All 47 siphons for the second barrel will be of precast, reinforced concrete pipe.

Because of the size of the pipe and the distances involved the contractor will erect a semi-portable field plant in the desert to produce the pipe. This field plant will be located near Desert Hot Springs and, later, at Freda Siding near Rice. The siphons, which will be fabricated in 16-ft sections, vary in length from 73 to 15,400 ft. Inside diameter range is from 13 to 13½ ft.

The present project is part of the Metropolitan Water District's $200,000,000 expansion program, described in the December 1956 issue (page 58) by Robert B. Diemer, M. ASCE, chief engineer and general manager of the district. The supplemental Colorado River supply, made available by the current project, will be enough to supply an additional 4,000,000 people, according to Mr. Diemer. The overall expansion program, scheduled for completion in 1960, is expected to relieve Southern California's water shortage until 1980.

Assistant Secretary of AIME Retires

Ezra J. Kennedy, Jr., assistant secretary of the American Institute of Mining, Metallurgical, and Petroleum Engineers, has retired after 31 years on the headquarters staff. Mr. Kennedy was named assistant to the Secretary of AIME in 1926, and assistant secretary in 1944. He has also been editor of the AIME Transactions and secretary of the Technical Publications Committee.



In this view gravel is being stockpiled by radial stacker shown at top of picture. Gravel is withdrawn from the stockpile by conveyors in tunnels under the stockpile, as shown at the bottom of the photo.

Conveyor Moves Mountain for Great Salt Lake Crossing

A giant, high-speed conveyor system, the largest ever built in terms of ton-miles per hour capacity, has been placed in operation at Little Valley, Utah, where it is moving a mountain two miles and dropping it in Great Salt Lake. The 30 million tons of gravel transported by the carrier are fill for the Southern Pacific Railway's new 13-mile roadbed across the lake. The new crossing will replace a trestle mounted on wood piles, which has carried rail traffic over the lake for over fifty years.

The big earth-moving and construction project, which is scheduled for completion in 1960, will cost Southern Pacific about $49,000,000. It is being built by the Morrison-Knudsen Company, engineering and construction firm with headquarters at Boise, Idaho. The conveyor system was designed, manufactured, and installed by Hewitt-Robins, under a subcontract with Morrison-Knudsen.

The system consists of two main cross-country units, plus eleven smaller conveyors, linked together to provide continuous flow of material from the mountain to the lake. Three 300-hp electric shovels gouge the gravel out of the mountain in 8-cu yd bites. The gravel is then trucked to a dumping station and deposited in hoppers, which feed it to the conveyor system. Stone 8 in. in dia and over is crushed before it goes into the hoppers.

The main conveyor belts, which are 54 in. wide, travel at 850 fpm, about twice the normal speed for conveyor belts. They handle about 4,200 tons an hour, a new record for overland conveyor haulage. To prevent excessive belt wear at such high speeds, accelerating conveyors 30 ft long and 60 in. wide are used at the loading hoppers and at transfer points on the main line. Moving material at a speed of 500 fpm, these belts ease transfer to the main belts.

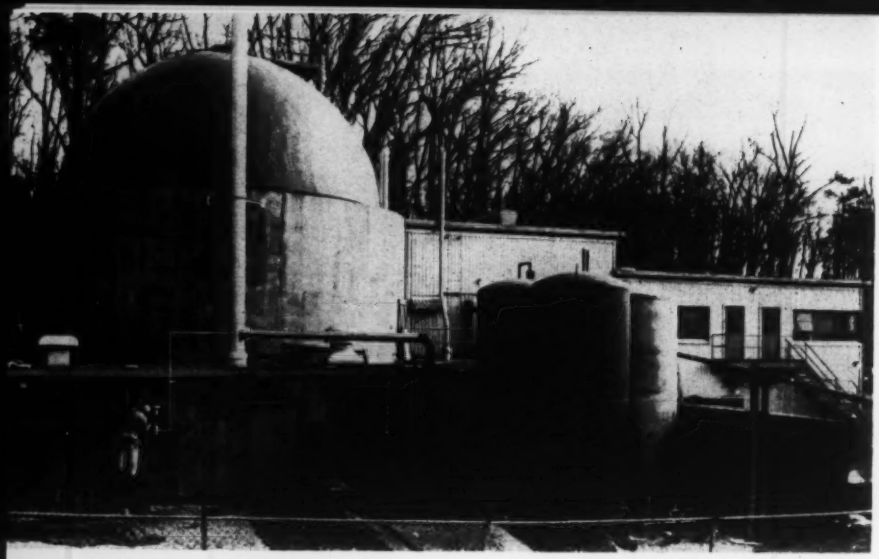
With the main belts coasting down grade under gravity, the conveyor actually generates power instead of consuming it. Engineers estimate that the motors generate about 618,000 w an hour—enough to fill the power needs of 4,000 average homes—which is fed to the electric shovels. A special patented drive mechanism, consisting of a drive pulley and a hold-back pulley, is used to transmit power to the conveyors and to control their descent.

When the gravel reaches the end of the main conveyor system, it is transferred to a radial stacker capable of building a 250,000-ton storage pile 70 ft high. The stacker is equipped with a 54-in.-wide belt conveyor mounted on a 164-ft radial boom. Under the stockpile there are two tunnels housing a pair of 72-in.-wide conveyors, which run at 600 fpm dumping the material into enormous bottom barges (250 ft long and 55 ft wide) for transport to the construction site. These conveyors can load a 3,000-ton barge in 15 minutes.

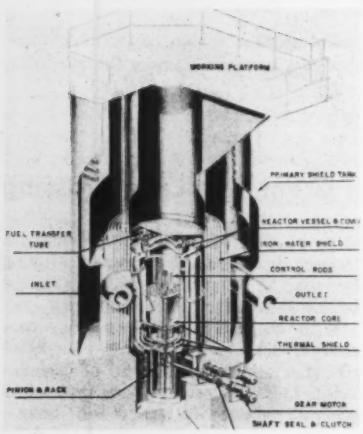
To provide a solid foundation for the fill, the lake bottom is being dredged of soft unstable material. It is estimated that 15,000,000 cu yd of material will be dredged out, creating a trench 170 to 475 ft wide and 20 to 35 ft deep. After the fill is in place, the top will be reinforced with heavy rock to resist the high waves that sweep the lake in storms. The new roadbed will run parallel to and about 1,500 ft north of the present wooden trestle.

An article on the project is scheduled for a forthcoming issue.

Army Package Power Reactor in Operation



Army Package Power Reactor at Fort Belvoir, Va., began operation in April. Vapor container at left, which includes the reactor core and steam generator, may be omitted in a remote location.



Isometric cut-away drawing shows reactor vessel, core, and control rods. APPR contains seven control rods, two normally in fully-withdrawn position.

The Army Package Power Reactor (APPR) began operation on April 8. This trim plant is located in a neat fenced-in space of less than an acre on the bank of the Potomac River at Fort Belvoir, Va., in the area of the U. S. Engineer Research and Development Laboratories (ERDL). In the dedication ceremony on April 29 Wilbur M. Brucker, Secretary of the Army, and Lewis L. Strauss, chairman of the Atomic Energy Commission, together closed the switch that connected the output of APPR with the Virginia Power Co. lines supplying Fort Belvoir with electrical energy. The unit is to be subjected to a 700-hour test run under full load output of 2,035 kw.

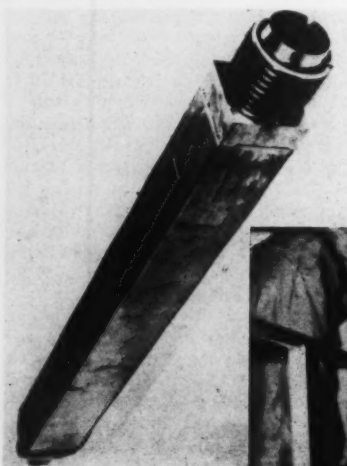
The reactor is dubbed a "package" plant because the component parts are of such size and weight that they could be transported by plane—Air Force C-124, for example—to advance bases in the Arctic, on an island, or in a desert area where planes can be landed. On a "crash" basis, assembly of the "packaged" components, after arrival in from 50 to 100 plane loads, would take as little as six months. Packages would be no larger than 10 by 10 by 20 ft and weigh no more than 25 tons.

The plant as erected at Fort Belvoir is neither portable nor even demountable. It is a permanent installation. Its reactor, steam generator, and pressurizer are inside a concrete-shielded upright cylindrical steel vapor container, 36 ft in dia and 64 ft high, to make it supersafe for operation in a populated area and for training of military specialists (see Fig. 1). In an advance base, where a power reactor of this size and type would be installed, the vapor container and its 5-ft-thick concrete biological shields probably would be omitted. The great military advantage of such a power plant is that it is designed to operate at full thermal load of 10,000 kw for 18 months on a single charge of a few pounds of fully enriched uranium dioxide nuclear fuel. The equivalent fuel in coal would weigh 18,000 tons.

After many proposals had been studied, a pressurized-water reactor was adopted for APPR—a type that has proved satisfactory in the submarine *Nautilus*. The contract to build this plant was awarded by the AEC for the U. S. Army to Alco Products, Inc., on December 10, 1954, and ground was broken on October 5, 1955. Stone and Webster Engineering Corp. built the plant for Alco.

Heat from the reactor core is removed by water in a primary loop, under 1,200 psia pressure to prevent boiling, which is pumped through and around the fuel rods at the rate of 4,000 gpm to a steam generator. In operation, the water at the outlet of the core is 450 deg, at the inlet 431 deg. In the steam generator the heat converts water in a secondary loop to steam which drives a conventional steam-turbine-driven electric generator of 2500-kva capacity.

The components in the secondary loop are small-scale duplicates of those used in a conventional steam plant. In the



A fuel element is an assembly of 18 fully enriched uranium oxide plates, clad in stainless steel. The core contains 38 of these fuel rods and seven control rods of similar size and shape.

Army technicians load fuel elements into reactor core through water shield.

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primary system the principal feature is the reactor core—the heart of the plant. Housed in the core are 38 uranium fuel elements, and seven control rods disposed vertically in a 7-by-7 design with the corners missing. Each fuel element consists of 18 stainless-steel-clad fuel plates 0.03 in. thick and spaced 0.133 in. apart brazed into a pair of stainless steel side plates 27 in. long and 2.86 in. thick. Both fuel and control rod elements were fabricated by the Oak Ridge National Laboratory. A Westinghouse "canned-rotor" pump circulates the primary system water through and between the fuel plates to the steam generator.

Control of the plant is from a switch board room filled with flashing lights, meters, control levers, and scramming devices. Should power reach an unsafe load the clutches holding the control rods out of the reactor core are released electronically to drop by gravity into place in the core, thus shutting down the reactor. Control is made easy by a strong negative temperature coefficient—as the reactor's heat rises the reaction drops off. Operations to date have been very satisfactory. In normal operation a five-man shift is required.

The overall construction cost of the plant is estimated at $3,500,000 broken down about as follows: architectural engineering, $330,000; fabrication and construction $2,700,000; fuel elements and control rod fabrication $120,000; and tests, a 700-hour run followed by six-month operation, $350,000.

AEC Chairman Strauss stated at the dedication of APPR that "we have fully declassified the details of design of this reactor . . . industry has complete access to its technology, and can draw upon it for the development of commercial plants for use here and abroad."

A similar plant is scheduled for installation in an Alaskan location where supplying fuel is a problem.

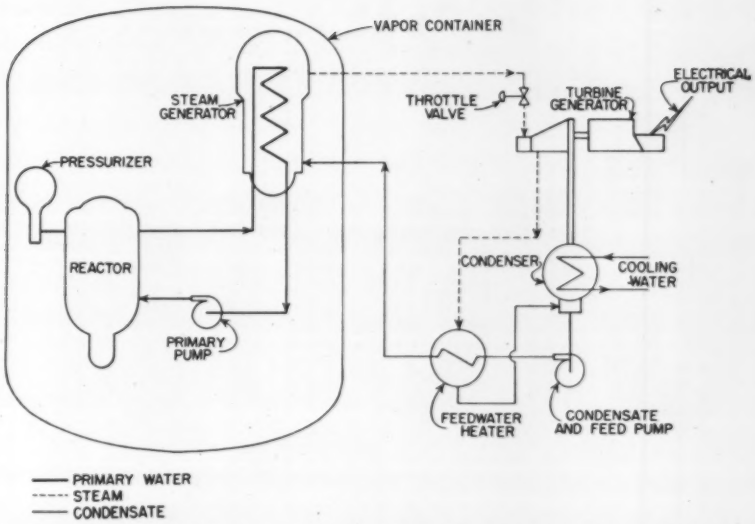

FIG. 1. Simplified flow diagram of Army Package Power Reactor. The primary loop and its reactor components are enclosed in a vapor container as protection against unlikely accidents.

Role of Concrete Pipe in Highway and Sewerage Expansion Studied

The chief business before the 175 experts attending the 49th annual convention of the American Concrete Pipe Association, held recently in Washington, D. C., was strengthening the position of the concrete pipe industry for the two most fabulous construction programs in the nation's history—the multi-billion-dollar highway program and the multi-million-dollar sewerage program. Revolutionary new specifications for concrete pipe, new hydraulic studies on culverts and sewer junctions, new design criteria for load computations and hydraulic computations, and studies of gasket specifications for coupling concrete pipelines were among the topics of discussion.

Foreseeing the need in the new highway program for large-diameter culverts under high fills, the Bureau of Public Roads has been preparing new design criteria. These criteria presented a challenge to the concrete pipe industry to design and produce concrete pipe to meet various strength requirements. The industry has met the challenge by preparing empirical and mathematical designs for pipe. The designs have been successfully tested and now form the bases for five new tables approved by the American Society for Testing Materials to replace the present C 75 and C 76 specifications for reinforced concrete sewer and culvert pipe. The new ASTM specification, which is identified as C 76-57T, has five strength classifications. It will be available for distribution this June.

Carl F. Izzard, A.M. ASCE, and Herbert G. Bossy, M. ASCE, of the Bureau of Public Roads, have recently issued hydraulic tables enabling engineers to determine the proper culvert size for a particular slope. Charts enabling rapid calculation of culvert sizes are also being developed at the Bureau of Public Roads office in Portland, Ore. The American Concrete Pipe Association will publish and distribute a handbook on the same subject later this year.

The concrete sewer pipe industry had new developments to report in studies on self-cleansing velocities, adequate grades, and junctions. Richard D. Pomeroy, M. ASCE, Los Angeles consulting engineer, reported on refined techniques for determining minimum velocities to prevent noxious hydrogen sulfide formation in sewers. Test results on junction studies at the University of Minnesota were also reported to the convention. Philip W. Manson and Fred W. Blaisdell, M. ASCE, of the university, have shown that a 90-deg junction is for practical design purposes equal in hydraulic efficiency to a wye or lateral junction entering a main line at a reduced angle.

A special committee of the association, headed by Henry M. Shaw of N. C. Products Corporation, Raleigh, N. C., reported progress in preparing a general specification for rubber gaskets to prevent infiltration and exfiltration in concrete pipe sewer lines. An enlarged committee will continue this important work.

Headquarters of the association's 50th anniversary meeting will be the Roosevelt Hotel, New Orleans, La. March 11-16, 1958.

The headquarters office of the ACPA is at 228 N. LaSalle St., Chicago.

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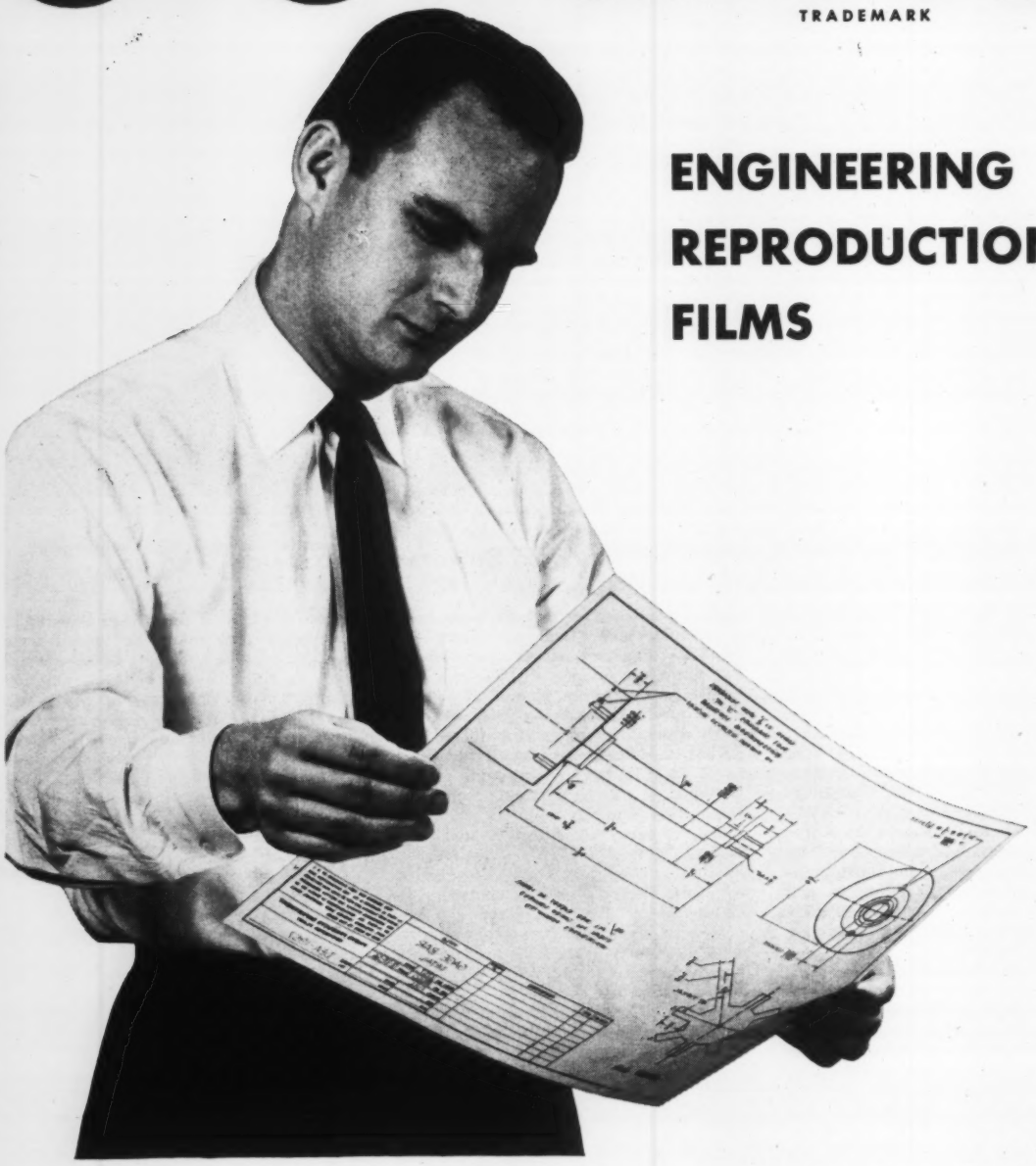

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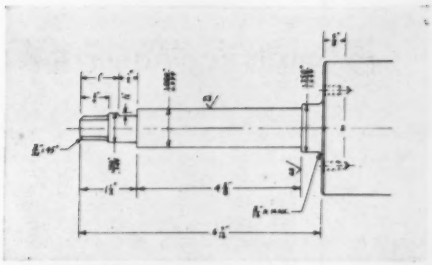

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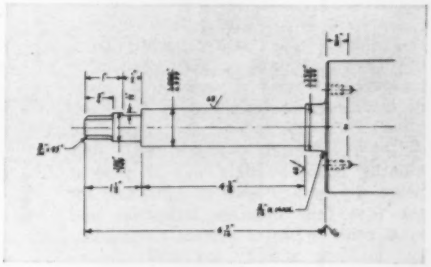

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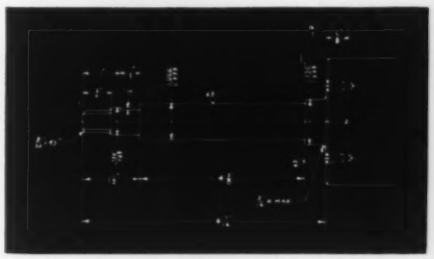

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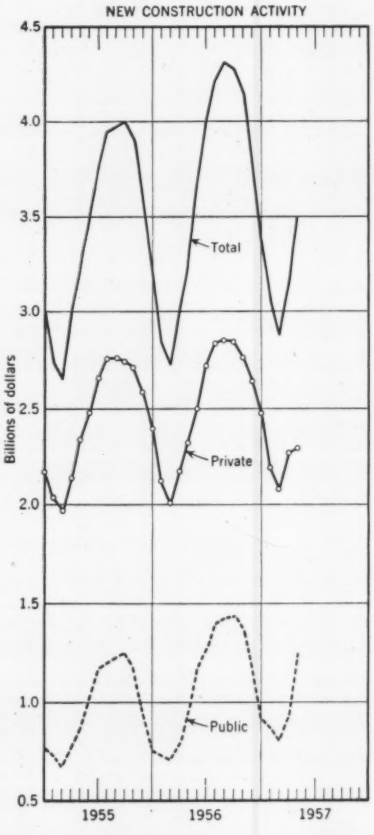
Construction Activity Rises Seasonally in April

The value of new construction put in place in April increased seasonally by 10 percent to $3.5 billion, according to preliminary estimates of the Departments of Commerce and Labor. With this advance the overall spending rate for new construction remained slightly ahead of April 1956 outlays. In addition, total outlays of more than $12.5 billion for the first four months of 1957 were up 2 percent over the total for the same period last year and set a new record for the period. Gains for new construction have been entirely in the public segment, since total private outlays for both April and the first four months edged off slightly from last year's record.

The flattening out in private construction activity has resulted mostly from the downward trend in house and store building. The value of work put in place on new nonfarm dewellings in April was off by 14 percent from last year, and down 11 percent for the first four months. Store building was 17 percent below a year ago both in April and for the first four months. Industrial and most other types of private nonresidential building activity are still running well ahead of last year. Public utilities also represent an area of strength in the current private construction picture with substantial increases in their outlays for new facilities.

Schools, sewer and water systems, and conservation projects account for a large part of the increase in public construction outlays over a year ago. Highway construction rose seasonally in April, but was only moderately above last year. More public funds are being spent this year for administrative and service buildings. Altogether public construction expenditures were up 10 percent from last year in April and 11 percent for the first four months.

Allowing for the fact that spending for new construction this year reflects an increase in construction costs, the actual amount of all new construction work put in place during the first four months, public and private combined, probably was slightly below a year ago.



Seasonal rise of ten percent in April construction outlays brings total for month to $3.5 billion, a slight increase over April 1956 total. Spending for first four months of 1957 was also up slightly.

Richard Johnson New President of Moles

Richard A. Johnson, president of the Arthur A. Johnson Corporation, has been elected president of the Moles, New York association of heavy construction engineers and executives. The election took place at the organization's annual meeting, held at the Biltmore Hotel on May 1. Mr. Johnson succeeds Thomas J. Walsh, Jr., president of the Walsh Construction Co. He is the first "second generation" president of the Moles, his father, Arthur A. Johnson, Aff. ASCE, having been president in 1944.

Richard Johnson

Other new Moles officers are Howard A. Collins, of the construction company bearing his name, first vice-president; Mansell L. MacLean, A.M. ASCE, of MacLean-Grove & Co., second vice-president; and John A. Lambert, of the McKiernan-Terry Corp., sergeant-at-arms. Richard M. Johnsen, of the Foundation Co., was reelected treasurer; and Gilbert M. Serber, M. ASCE, president of the Stock Construction Co., secretary.

Engineers Oppose Unionization At Minneapolis-Honneywell

National Labor Relations Board held on May 8 separate representation elections for the engineers, and for the technicians, employed by the Minneapolis-Honneywell Regulator Co. at its Minneapolis plant. Separately the engineers were asked, if a union were certified, should it be composed of engineers only, or include the technicians also. On this choice the engineers voted 974 to 429 in favor of a union composed of engineers only. The alternatives voted on by both the engineers and the technicians were: (1) no union affiliation; (2) representation through United Auto Workers (AFL-CIO); or (3) through Engineers and Scientists of America (ESA). The vote on the latter alternatives were as follows:

Item	*Engineers (1451 Eligible)*	*Technicians (746 Eligible)*
No union	896	404
UAW	314	254
ESA	197	62
Totals	1,407	720

In commenting on the election, J. W. Barker, president of EJC, said the results support the basic statement made in 1956 by EJC that, "collective bargaining with its attendant potentiality for creating conflicting obligation is not acceptable to engineers."

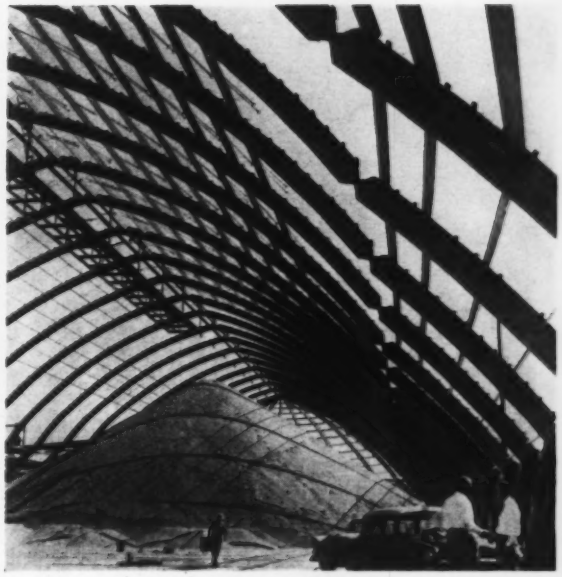
Transactions of Fifth Congress on Large Dams

Availability of the Transactions of the Fifth Congress on Large Dams, which was held in Paris in June 1955, is announced by the U. S. National Committee on Large Dams of the International Commission on Large Dams. Selling price of the four-volume set is $48 to members of the U. S. National Committee, and $60 to non-members. Purchasers of ten or more sets will be billed at the price quoted for members. Separate volumes will not be available.

In this country the Transactions will be sold only through the U. S. National Committee on Large Dams, which has its headquarters at 29 West 39th Street, New York 18, N. Y. Orders should be submitted promptly, as the U. S. Committee must place a firm order for a definite number of sets with the Central Office in Paris and has to know exactly how many sets will be required. Additional sets cannot be ordered after the original order has been placed.

Timber Frame Structure Provides Unique Storage Warehouse

This giant timber-framed warehouse for chemical storage—recently completed for the Potash Company of America at Carlsbad, N. Mex.—is unusual in that it was constructed around and over an 80,000-ton pile of potash, which had been in open storage. The structure, measuring 580 by 180 ft, is an arched-bent design with timber buttresses anchored into a continuous, concrete pilaster wall which in turn supports large, three-hinged, glulam wood arches. Twelve flat cars were required to haul the huge roof arches, which were fabricated and erected by Timber Structures, Inc., Portland, Ore. Use of the buttressed arch design made it possible to build a larger post-free structure at lower cost and with shorter main arches.



N. G. Neare's COLUMN

R. ROBINSON ROWE, M. ASCE

"I'm smarter than Seymour," bragged Joe Kerr.

"So you're smarter than Seymour V. Hickels," echoed Professor Neare. "If you solved his problem, how do you know you did it better, or quicker?"

"I didn't solve it, but if he had been smarter like me, he would have put two optical counters on his car and measured inbound and outbound traffic separately. I plotted his data (Fig. 1), with his count in vehicles per hour against his speed in miles per hour. Points A, B, C and D lie on a parabola EABCD. I tried to get the equation for it so as to find the count past a fixed point, when speed was zero, but I ran into some big numbers and had the brilliant idea of two counters."

"Some brilliant people waste their time making easy problems hard," interposed Cal Klater. "Instead of a parabola, you had a hyperbola, the trivial kind consisting of the two straight lines AB and CD intersecting at F. For A and B, Seymour was being overtaken by inbound traffic, while for C and D he was doing the passing. The break at F was the speed, 53 mph, of inbound traffic. The slopes -22 and $+60$ of AB and CD are in vehicles per mile, respectively, for difference and sum of outbound and inbound traffic density, so these are 19 and 41 vehicles per mile. At F he would have been counting 2090 vehicles per hour, all outbound, so his speed relative to outbound traffic was 2090/19=110, and outbound traffic speed was 110—53=57 mph.

"If that sounds too complicated, here it is in equation form:

$$x(u\text{-}40) + y(v+40) = 2376 \quad . \quad . \quad . \quad . (1)$$

$$x(u\text{-}48) + y(v+48) = 2200 \quad . \quad . \quad . \quad . (2)$$

$$x(60\text{-}u) + y(v+60) = 2510 \quad . \quad . \quad . \quad . (3)$$

$$x(70\text{-}u) + y(v+70) = 3110 \quad . \quad . \quad . \quad . (4)$$

$$8(x\text{-}y) = 176 \quad . \quad . \quad . \quad . \text{from (1)-(2)}$$

$$10(x+y) = 600 \quad . \quad . \quad . \quad . \text{from (4)-(3)}$$

whence $x=41$, $y=19$, $u=52$ and $v=57$."

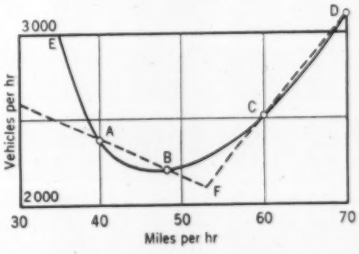


Fig. 1. Parabola or hyperbola? Cal knew.

"That wasn't the real question," protested Ira Bell. "Like going to St. Ives, he asked how many cars were going how fast each way. You found how fast and how dense, but not how many!"

"I know," yipped Joe Kerr. "198+220+251+311=980."

"That's what he counted, but he counted some cars twice. Now if you separate inbound from outbound traffic, you'll find that Seymour was overtaken by 44.42 cars in the first 5 min and by 20.5 in the next 6 min, then he overtook 28.7 and 69.7 cars in the last two periods. Are these fractional cars wrecks or foreign miniatures?"

"I'll have to answer that," laughed the Professor. "Equations (1) to (4) are really step functions, since the counter clicks off each car and doesn't turn continuously or record fractions. We can use the functions as if they were continuous, then round answers to integers. So the answer to Ira's question, which I didn't intend, is 915 cars, of which 817 were outbound and 98 inbound, 65 of the latter being counted twice.

"Now I'd like to tell you about a number which I will represent by NOPQRSTUVWX, although obviously there is some duplication in the 11 digits. It is an interesting number because NOPQRSTUVWX is a perfect square, and so is NOPQRSTUVW. Now since Joe likes small numbers, I'm just going to ask him to find X; Cal who likes big numbers can find the rest of it. Take it along on your vacation."

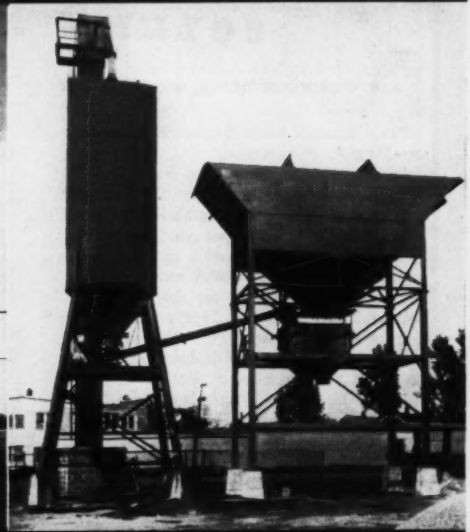
[Solutions to the March problem of probability of droughts were received from Thatchrite (Guy C. Thatcher), Rudolph W. Meyer, Arthur W. Trapp, and Neil W. Lane. Cal Klaters this month were: Richard Jenney, Ignor Antenuf (Paul Hartman), Henry Troelsch, S. L. Dum (Thomas Borman), Ad L. Pate (G. H. Wilsey), Thatchrite, Marvin Larson, S. K. Rueball (Keith Jones), and Ed. C. Holt Jr.]

Here's the Nation's Outstanding Bulk Cement Batching Plant Offer

Long known to be the best engineered plant, increased demand for the Heltzel E-3, has resulted in production economies you'll want to know more about

Standard 609 BBL E-3 Plant provides low cost, large capacity bulk cement operation for Georgia ready mix firm.

Large Indiana highway paving contractor finds his E-3 Plant with recirculator gives him maximum portability, capacity and speed.



New Jersey ready mix operator teams the E-3 with Heltzel's rugged type 200 Aggregate Plant for fastest one-stop batching service.

133

Illinois paving contractor uses the Heltzel E-3 with extra large ground cement storage to provide high speed batching for modern paving operation. Note piers for addition of third 1000 BBl. recirculator.

Ohio paving contractor selected this E-3 with recirculator after comparing with several other makes. He reports the plant is most versatile, fast and exceedingly accurate.

● The Heltzel E-3 Bulk Cement Plant has long been recognized as the industry's finest engineered plant. Now, because of an increased demand, Heltzel has set up a new production facility that has resulted in economies that enable us to offer this outstanding plant at standard equipment prices.

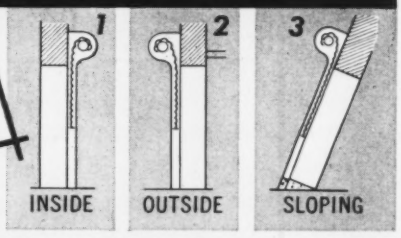
There is absolutely no quality reduction! You get the all butt-welded bin with rounded corners (fabricated by an automatic welding process) that assures smooth flow and guarantees water tightness. You have your choice of Heltzel's patented tubular valves—with or without rotary vane feed. The rugged wide flange, flare-leg supports that mean extra rigidity and truck room! All connections are out in the open, easily accessible for fast, easy erection or dismantling.

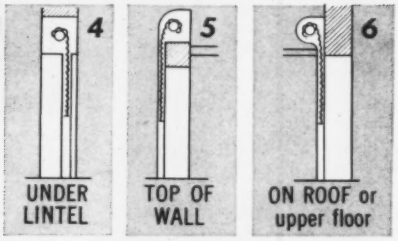
Select your capacity—from 250 BBls to 670 BBls—portable recirculators up to 1000 BBls each. Choose your batcher-manual, semi- or fully automatic from 16 to 60 cubic feet including the outstanding Heltzel Twin Batcher designed for high production paving operations. Plants available with "unitized construction"—factory assembled in units for even faster erection and dismantling.

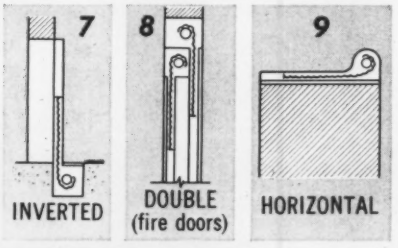
Whatever your needs you will want to get all the facts on this exceptional offer before you buy. Contact your Heltzel representative—or write direct.

THE HELTZEL STEEL FORM AND IRON CO., 418 THOMAS RD., WARREN, OHIO

Quick Guide to Kinnear Door Versatility





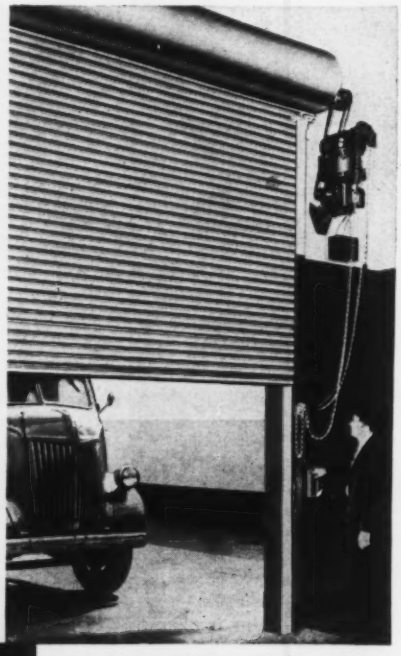


Kinnear Steel Rolling Doors

Whether your door needs are standard or special, Kinnear Rolling Doors offer you more efficiency *more different ways* than any other type of door. For example, the coiling upward action of Kinnear's interlocking steel curtain can be applied:

1. Mounted on inside wall; coils overhead.
2. On outside wall; leaves ceiling clear.
3. Sloping doorway (chutes, hoppers, etc.).
4. Hood under lintel or concealed in wall.
5. Hood above lintel or on top of wall.
6. Hood above roof or upper floor level.
7. Inverted mounting (coil below door sill).
8. Kinnear Rolling Doors (automatic fire type) on both sides of wall for maximum fire protection.
9. Horizontal mounting (openings for observatory, ventilator or similar eqpt.).

In *every* installation, Kinnear Rolling Doors open *out of the way* . . . need no usable space for either storage or operation . . . give extra protection against fire, theft, wind, weather or vandalism. Extra heavy galvanizing assures corrosion-free durability. Built any size. Motor or manual operation. Write for full information!



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Saving Ways in Doorways

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FACTORIES:
1080-90 Fields Avenue, Columbus 16, Ohio
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DECEASED

John Anderson (M. '39), age 78, who retired early this year as head of the civil engineering department at The Citadel, Charleston, S. C., died February 17. Colonel Anderson was a member of The Citadel faculty for 38 years, and had been head of the department since 1955. During his long tenure with The Citadel he was influential in placing its civil engineering department on the approved list of the Engineering Council for Professional Development. Colonel Anderson was educated at the University of Glasgow Royal Technical College.

George Baum (M. '06), age 88, former president of Adam Cook's Sons Inc., Linden, N. J., died recently. Mr. Baum became connected with the company in 1906. Earlier in his career he was superintendent in charge of construction for the Ontario Power Company in Clifton, Canada, and worked on the Bull Sluice Dam, Roswell, Ga. Mr. Baum graduated from Rensselaer Polytechnic Institute in 1891 with a civil engineering degree.

Charles Beverly Benson (M. '40), age 61, consulting engineer on railroad problems for the New York Public Service Commission, New York City, died in a White Plains hospital on April 2. He lived in Hartsdale, N. Y. Mr. Benson became connected with the Public Service Commission in 1941 as a statistics and research engineer, and later became principal statistics engineer. In the field of railroad safety, he was responsible for the installation of an electronic speed control system on the Long Island Railroad. Earlier in his career he had been an instructor in mechanics and hydraulics at Cornell University and assistant professor of civil engineering at Purdue University. Mr. Benson was educated at Cornell and Columbia universities.

Franklin Jackson Blythe (M. '51), age 68, president of the Blythe Bros. Construction Company of Charlotte, N. C., died there on March 7. For 35 years Mr. Blythe headed the construction company bearing his name which he and his brother formed in 1921. During World War II he won government citations for building military installations all over the world. He headed the construction group that built the Marine Base at Camp Lejeune. Active also in politics since 1949, Mr. Blythe was state senator from Mecklenburg County until illness forced his retirement in February. He attended the University of North Carolina.

John Henry Bond, Jr. (M. '52), age 28, assistant foreman of the Bethlehem Steel's Pottstown plant, Pottstown, Pa.,

(Continued on page 106)

The answer to lower roadbuilding costs...

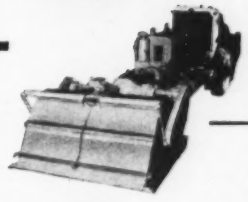
The right machine at the right stage

BROS SELF-PROPELLED ROLLER

Sealcoat, surface and subbase compaction work accomplished in fastest time possible with the BROS SP-54 roller. Infinite speed range from 0 to 18 MPH, both forward and reverse; torque converter drive; full oscillation of ALL wheel pairs; positive chain drives to both rear wheel pairs; engine, gasoline (or diesel) produces 50 usable horsepower at 2000 RPM; smooth automotive-type hydraulic steering.

BROS ROTO-MIXER

In-place mixing and blending of surface, subbase and subgrade materials to 12″ depth with heavy duty BROS Roto-Mixer. Solid steel rotor shaft; positive equally loaded chain drives to both ends of shaft; simplified split-sleeve type tool plates. Hood and rotor each power hydraulically controlled.



BROS PREPARATOR

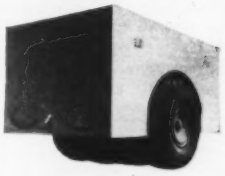
In-place reduction of subbase aggregates from over-size pit or bank-run materials. Reduces up to 400 cu. yds. per hour to acceptable gradation percentages. Also prepares scarified asphalt materials to proper sizes for re-use.

BROS TOW-TYPE ROLLERS

For surface and subbase and shallow lift subgrade compaction. 9 and 13 ton capacities; ½″ overlapping wide face tires for full coverage; full oscillation of all wheels. Wobble-wheel* action adds side-to-side weaving motion to knead out voids and material bridging.

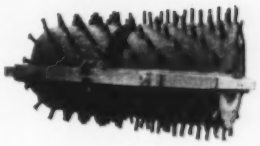
BROS ROLL-O-PACTOR

35, 50 to 100-ton. Heavyweight champion for compacting subgrade, earthfills, airfields and dams in lifts up to 24″. 19° wheel oscillation. Tire pressures up to 150 psi. Heavy duty wheel assembly and bearings.



BROS TAMPING ROLLERS

For subgrade and embankment constructions of non-granular soils. Capacities range from 133 to 725 psi foot pressures. Sheepsfoot and Diamondfoot. Large tamping face and relief shank design provide maximum compaction pressure with the least drag when rolling at all depths. Get full information and specifications on any of these machines from your nearest BROS Distributor or write us.



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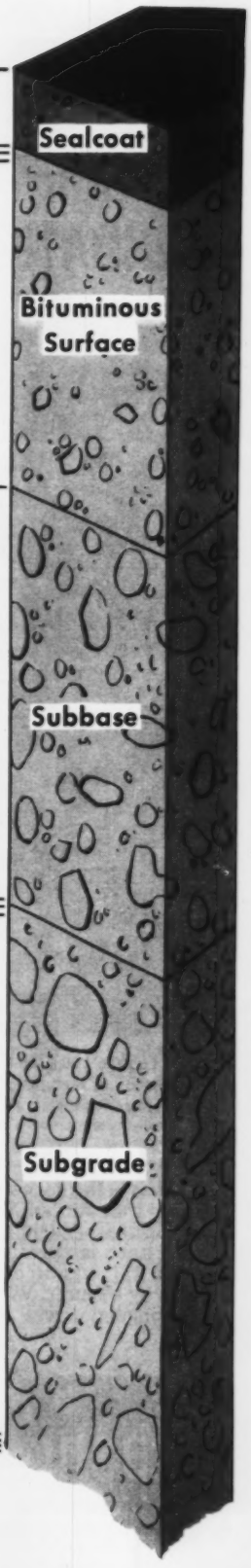

BROS

Road Machinery Division

BROS *Incorporated*

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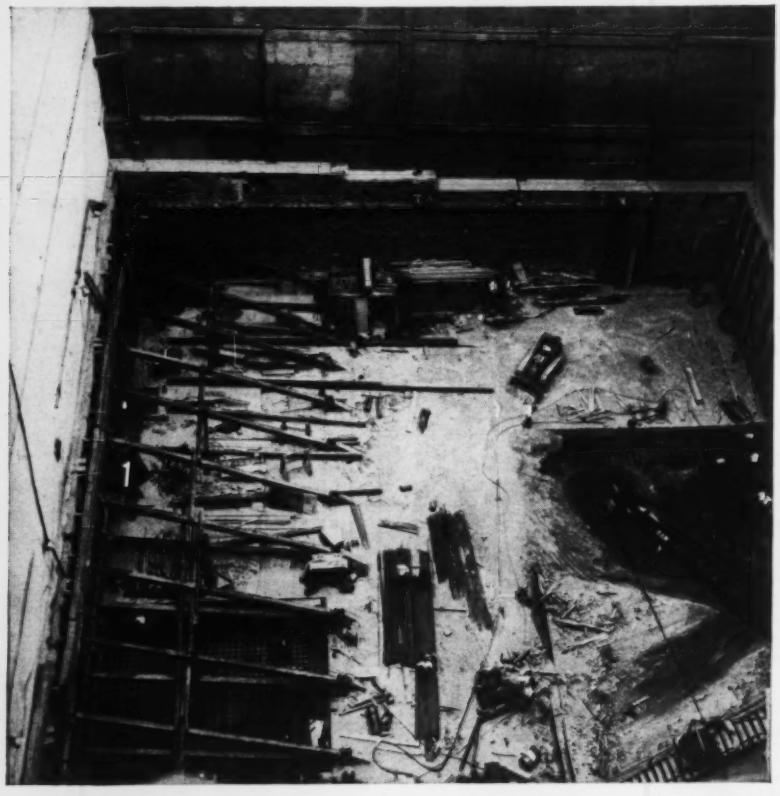
ANOTHER PROBLEM SOLVED BY SPENCER, WHITE & PRENTIS

3-SHIFT SCHEDULE SPEEDS FOUNDATION FOR JORDAN MARSH



1. EXISTING STORE UNDERPINNED AND BRACED. STREET BRACING DOES NOT SHOW IN THIS PICTURE. MINIMUM DEPTH OF CUT 30 FT. AREA 125 x 180 FT.

Project: Rebuilding Jordan Marsh, Boston Department Store, a section at a time.
General Contractor: Vappi & Co., Inc., Cambridge, Mass.
Architects: Perry, Shaw & Hepburn—Kehoe and Dean, Boston.
Engineer: Maurice A. Reidy, Boston.

This job is being done in separate sections, so that Jordan Marsh can continue business during construction. Shown here is the foundation for Section III, handled (as were the others) by Spencer, White & Prentis. Since completion was desired in time for the store's holiday-selling season, our men and machines worked round-the-clock for 3 months to excavate and pour mat on schedule. Photo shows the methods used to prevent movement of adjacent buildings and streets.

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Deceased

(Continued from page 104)

died in Philadelphia on February 12. Mr. Bond joined Bethlehem Steel in 1953 when he completed the Company's Loop Course. Earlier he served two years on the Korean front with the Army Corps of Engineers. He was graduated from Lehigh University in 1950, and received an M.A. degree from the University in 1951.

Robert Wesley Briggs (M. '22), age 69, consulting engineer of New Rochelle, N. Y., died at his home in Rye on April 5. A member of the consulting firm of Briggs, Blitman & Posner, which he organized in 1951, Mr. Briggs was designer of part of the $50 million New England Thruway. For nearly forty years Mr. Briggs was connected with the New York Central Railroad on the design of viaducts and other structures. He had also been associate professor of civil engineering at Columbia University and served as consulting engineer for the City of New Rochelle.

Arthur Henry Emerson (M. '36), age 71, for the past 28 years vice-president of the consulting firm of William T. Field Engineers, Inc., Watertown, N. Y., died recently. At one time Mr. Emerson worked on the preliminary surveys and studies for the Thousand Islands Bridge Project. He received his B.S. and C.E. degrees from Clarkson College of Technology, Potsdam, N. Y.

William Granville Gove (M. '10), age 83, who from 1905 until his retirement in 1944 was assistant general superintendent of the New York City Board of Transportation, died in St. Petersburg, Fla., on April 9. Earlier he served the New York City Transit system as assistant mechanical engineer, and as superintendent of equipment. He had been president of the American Electrical Railway Engineering Association and the New York Railway Club. Mr. Gove was educated at the Cincinnati Technical School (now the University of Cincinnati).

Wallace Greenalch (A.M. '99), age 87, retired consulting engineer of Troy, N. Y., died recently. For many years he was deputy city engineer, superintendent and engineer of water works, and commissioner of public works for Albany, N. Y. While there he worked on the construction of Indian Lake Dam in the Adirondacks. Later in his career he joined the Foundation Company of New York City, as chief engineer of improvements on water supply and sewerage in Lima, Peru. He was graduated from Rensselaer Polytechnic Institute in 1893.

Peter Leo Hein (M. '38), age 73, retired consulting engineer for the Public Buildings Administration, Washington, D. C., died there January 27. Mr. Hein

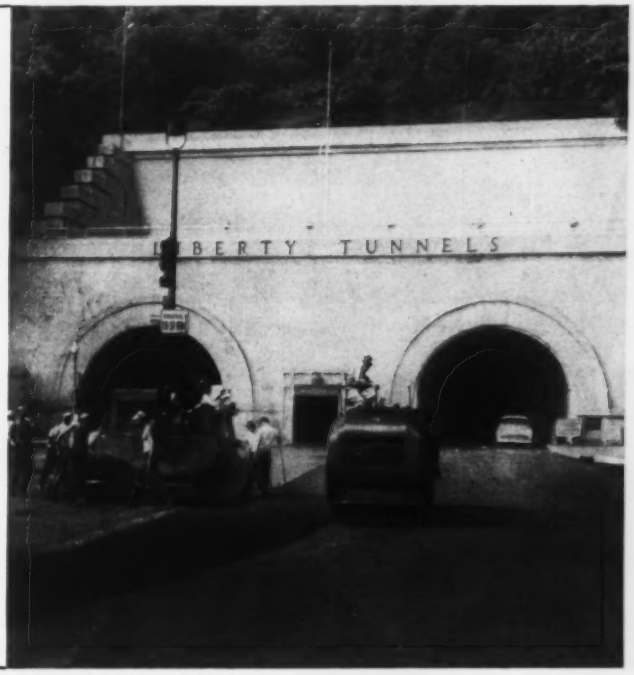
(Continued on page 108)

Nationwide service on Bitumuls & Asphalt for every paving need...all from <u>one</u> source!

PENNSYLVANIA: Laykold® Asphaltic Concrete solves a tough paving problem on the Liberty Bridge, a major approach to downtown Pittsburgh. (When it comes to pavements, bridges are notoriously "bad actors" because expansion and contraction of the deck result in an unusual degree of movement under the surfacing). Based on previous use of Laykold Asphaltic Concrete, Department of Public Work officials for Allegheny County knew that this material retained an extra measure of resilience after placement and compaction, with no decrease in load-bearing value.

Mixed with slag aggregate, a 120 lb. "LAC" binder course and a 100 lb. "LAC" surface course were placed over an area of some 32,000 sq. yds. Trumbull Construction & Asphalt Company of Pittsburgh did the work. American Bitumuls & Asphalt Company supplied the asphalt and the Laykold Tempering Fluid.

Results to date: excellent service; no pavement failures.



CALIFORNIA: Across the nation, on the Pacific Coast, the State of California Department of Highways let a half-million-dollar contract for re-surfacing 41 miles of U. S. Highway 99 to the Schroeder Company, of Sun Valley, California. For this job, American Bitumuls & Asphalt Company supplied: 1,700 tons of Air Refined Asphalt; 3,500 tons of Paving Asphalt; 140,000 gallons of Bitumuls® Emulsified Asphalt.

LOUISIANA: While "down South," on the construction of a road for private industry at Grand Isle, La., American Bitumuls & Asphalt Company supplied Bitumuls Emulsified Asphalt for 20,000 sq. yds. of 3-course surface treatment work on which *clam shells* were used as aggregate. As cover aggregate, shell produces a long-wearing surface.

Whenever . . . and wherever . . . your paving job calls for asphalt or asphaltic products, call our office nearest you. *That's your single source for all your asphalt requirements.*

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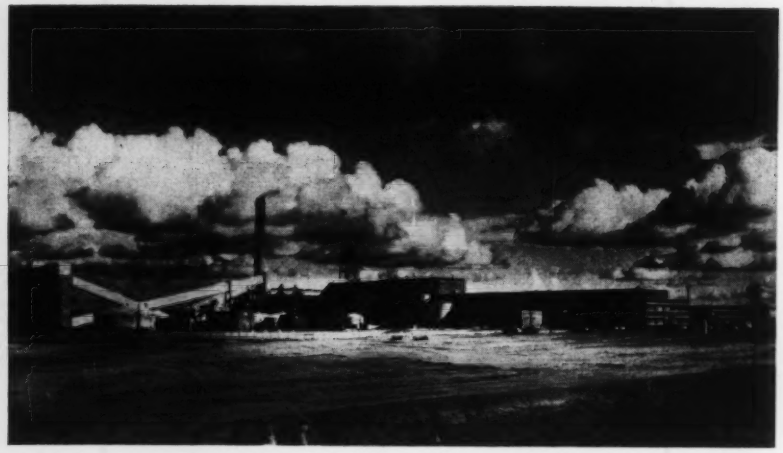
Baltimore 3, Md. St. Louis 17, Mo. Cincinnati 38, Ohio
Mobile, Ala. San Juan 23, P. R. Tucson, Ariz.
Inglewood, Calif. Oakland 1, Calif. Portland 7, Ore.



Rayonier Plant, Jesup, Ga. Engineers and constructors: Ebasco Services, Incorporated

Vibroflotation®

presettled sandy surface from 7" to 13" over the entire foundation area of 175,300 sq. ft. at Rayonier Plant. The depth of compaction was 16 to 20 feet.

The subsequent foundation settlement, even under the heaviest dynamic loads, was less than ⅛th of an inch. Soil compaction by Vibroflotation was first used at Jesup in 1952. Because of the good results of this rapid and economical foundation solution, it was used again for expansion at this plant in 1956.

Vibroflotation in action at Jesup. Approximately 1,000 cubic feet of loose granular soil was compacted by a single vibroflot penetration to a depth of 20'.

The most recent addition at Jesup involved compaction of 1,777,000 cubic feet to a minimum relative density of 70% and an additional 631,000 cubic feet at a minimum density of 85%. This work required 3212 Vibroflotation compactions and was completed in six months.

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ATlantic 1-2500

V-12

Deceased

(Continued from page 106)

became connected with the Administration in 1934 and remained with it until his retirement in 1954. Earlier in his career he had been a partner in the firm of Lieberman and Hein, consulting engineers, Chicago, Ill. Mr. Hein received a B.S. degree in civil engineering from Armour Institute of Technology.

Seward D. Hendricks (A.M. '13), age 73, retired executive of the Electro Metallurgical Company, Niagara Falls, N. Y., died there March 6. Mr. Hendricks joined the company in 1918 and remained with it until his retirement in 1949. During his long tenure he served as superintendent in charge of special alloys, assistant general superintendent of the Niagara Falls plant, and assistant to the works manager. Earlier he was connected with the Empire Engineering Corp. as contract engineer, working on the construction of the Erie Basin Barge Canal Terminal, Buffalo, N. Y. He was graduated from Union College in 1910.

Arthur Albert Johnson (M. '19), age 81, retired civil engineer, died recently in St. Petersburg, Fla., where he had lived for the past six years. Mr. Johnson's long career included work as associate engineer for the Corps of Engineers in New York City, and as assistant general manager of the Norfolk Creosoting Company, Norfolk, Va. His interest in corrosion led him to a study of shipworms, and one—the Teredo Johnsoni—was named for him. Mr. Johnson was in Europe with the American Relief Administration after World War I. He was a graduate of Butler College (now University).

Rudolph F. Kelker Jr. (M. '20), age 81, nationally known transportation authority, died on April 18 in San Mateo, Calif., where he had lived since his retirement ten years ago. While Major Kelker made traffic studies for several large cities, including New York, Baltimore, St. Louis, and Los Angeles, he was most prominently identified with Chicago transportation developments. As consultant to the city for more than twenty years, he prepared two major reports that established the basis for the program of the Chicago Transit Authority. For ten years he was also senior partner in the Chicago consulting firm of Kelker, De Leuw & Company, which he organized in 1919. He was a graduate of Pennsylvania State College, and a veteran of World War I.

Raymond Brown Kittredge (M. '26), age 70, professor of transportation engineering at the State University of Iowa, Iowa City, died recently. He was an alumnus of the University of Maine and taught there briefly before going

(Continued on page 110)

LOW...

for minimum depth

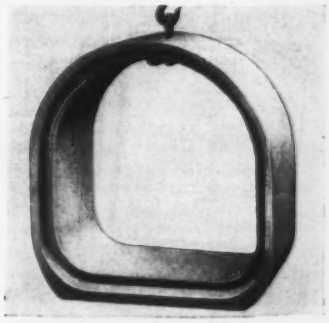
STRONG...for heavy loads

LO-HED

reinforced concrete pipe for culverts and sewers

Elliptical LO-HED Pipe carries a greater flow than its round equivalent in a shallower ditch—has the strength to support tremendous loads. It is easier to lay, to grade and line. LO-HED Pipe features smooth walls and tight joints for maximum hydraulic capacity with less build-up of debris in the invert, even under low-flow conditions. Write for free brochure containing hydraulic characteristics and discharge diagrams on a full range of sizes for nearly all culvert and drainage installations.

Our technical staff will be pleased to assist you with your pipe problems.



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Other uses for under-highway pipe are provided by Flat-Base . . . as an underpass for pedestrians, cattle and conveyances—as utility galleries or industrial tunnels. Write today for illustrated literature.

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- ☐ **TECHNICAL REPORT NO. 2**...Tests and Methods of Testing Polyvinylchloride Waterstops.
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- ☐ **TECHNICAL REPORT NO. 4**... Hydrostatic Pressure Tests on DURAJOINT and other Waterstops.
- ☐ **DURAJOINT** "Tech-Tip" Series.
- ☐ Have representative call.

DEPT. 20

NAME_____

FIRM_____

ADDRESS_____

CITY_____ STATE_____

Deceased

(Continued from page 108)

to the State University of Iowa in 1912. He had been professor of transportation since 1925.

Hans Kramer (M. '34), age 63, Brigadier General, U.S. Army (retired) and consulting engineer of San Francisco, died in February. His home was in San Mateo, Calif. He was educated at the University of Michigan and the U.S. Military Academy at West Point. As holder of the Society's Freeman Fellowship in 1930 and 1931, he studied at the University of Dresden, where he received his engineering doctorate in 1932. General Kramer's distinguished Army career included assignments as assistant district engineer at Philadelphia, Memphis, and Conchas Dam, N. Mex., and two important assignments in the Panama Canal Zone. In private practice since 1946, he was a member of the Board of Consultants for the Panama Canal and government representative on the Colorado-Kansas-Arkansas River Compact Commission. In his early career he taught military science at California Institute of Technology.

John Aloysius Lahmer (M. '08), age 83, retired senior assistant engineer for the Missouri Pacific Railroad St. Louis, Mo., died March 9. Mr. Lahmer was with the Missouri Pacific from 1915 until his retirement. Earlier he was connected with the Kansas City Southern Railway Company at Kansas City, Mo., where he was principal assistant engineer.

Frank R.S. Layng (A.M. '10), age 78, retired railroad executive of Greenville, Pa., died in a hospital in Coral Gables, Fla., on March 10. From 1900 until his retirement in 1948 Mr. Layng was with the Bessemer and Lake Erie Railroad Company, which he served for many years as vice-president and chief engineer. Mr. Layng was active in many professional societies, including the American Railway Engineering Association which he served as president in 1944-1945. He was a graduate of the Western University of Pennsylvania (now the University of Pittsburgh).

Laurence Edward Martin (A.M. '26), age 61, manufacturer's agent for the Young and Greenawalt Company, East Chicago, Ind., and the Manwaring Machine Company of Indianapolis, died recently. Mr. Martin had been connected with Carles W. Cole and Sons, Carbondale, Ill., as drainage engineer and personnel director on the construction of the Illinois Ordnance Plant. Mr. Martin graduated from Purdue University in 1922.

John Russell Montague (M. '56), age 65, engineering consultant for the Hydro-Electric Power Commission of Ontario, Toronto, Canada, died in January. Mr. Montague became connected with Ontario Hydro-Electric in 1922 as as-

(Continued on page 112)

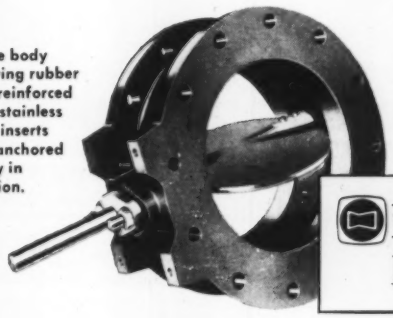
Free and Easy Operation

with BUILDERS 90° seating butterfly valves!

In laboratory tests, a Builders Butterfly Valve was cycled *over a quarter million times*, and tested bubble-tight at 25 psi. This is equivalent to opening and closing a valve 12 times a day for over 55 years. Throughout this test, valve operation was easy at all times . . . no "freezing" whatsoever was experienced. There was no sign of leakage at the gland and wear on shaft and bearings was negligible.

- **90° SEATING—truly balanced valve requiring no operator torque to maintain closed position.**
- **Adjustable mechanical stops to accurately locate valve disc in open and closed positions.**
- **Valve seats of natural rubber reinforced with stainless steel securely bonded into the rubber. Seat cemented and secured for stress-free, rugged bonding to valve body.**
- **Adjustable two-way thrust bearings insure that valve disc is accurately centered.**

If water means money to you, your client, or your community, investigate bubble-tight AWWA Standard Builders Butterfly Valves . . . built by specialists in water and sewage works equipment for these particular services.



Valve body showing rubber seat reinforced with stainless steel inserts and anchored firmly in position.

Request Bulletin 650-L1B which fully describes these and other design features. **Builders - Providence, Inc., 360 Harris Avenue, Providence 1, Rhode Island.**

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DIVISION OF
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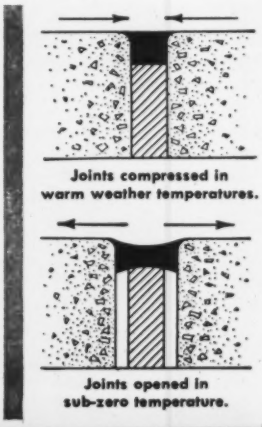
BIF METERS FEEDERS CONTROLS

Para-Plastic requires little or no maintenance!

Para-Plastic is the *original* hot-poured rubberized asphalt joint sealing compound that forms a resilient, adhesive and effective seal which maintains bond at sub-zero temperatures. Para-Plastic has unique characteristics of adhesion and cohesion that make it the most efficient joint sealer available today. Unaffected by extremes of temperatures, Para-Plastic insures a moisture-tight seal of expansion, contraction and dummy joints in concrete pavement. Hot Poured Para-Plastic meets Federal Specifications SS-S-164, CAA Spec. P-605, ASTM D-1190-52T, and many State Highway Specifications.

PERFECT SEAL FOR YEARS

Drawings at right illustrate the unique characteristics of Para-Plastic Joint Sealer during extremes of temperatures. The compound remains plastic at sub-zero temperatures and changes only slightly in hardness and viscosity during higher temperatures. Servicised technicians are available to assist you in waterproofing problems and to make recommendations for installations of a specific nature. Ask for details.



Joints compressed in warm weather temperatures.

Joints opened in sub-zero temperature.

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Deceased

(Continued from page 110)

sistant project manager. He had been superintendent of construction for the Raymond Concrete Pile Company in New York and Montreal, and chief engineer in charge of engineering and estimating for D. G. Loomis & Sons, Montreal. Mr. Montague was graduated from the University of Toronto in 1914 with a B.S. degree.

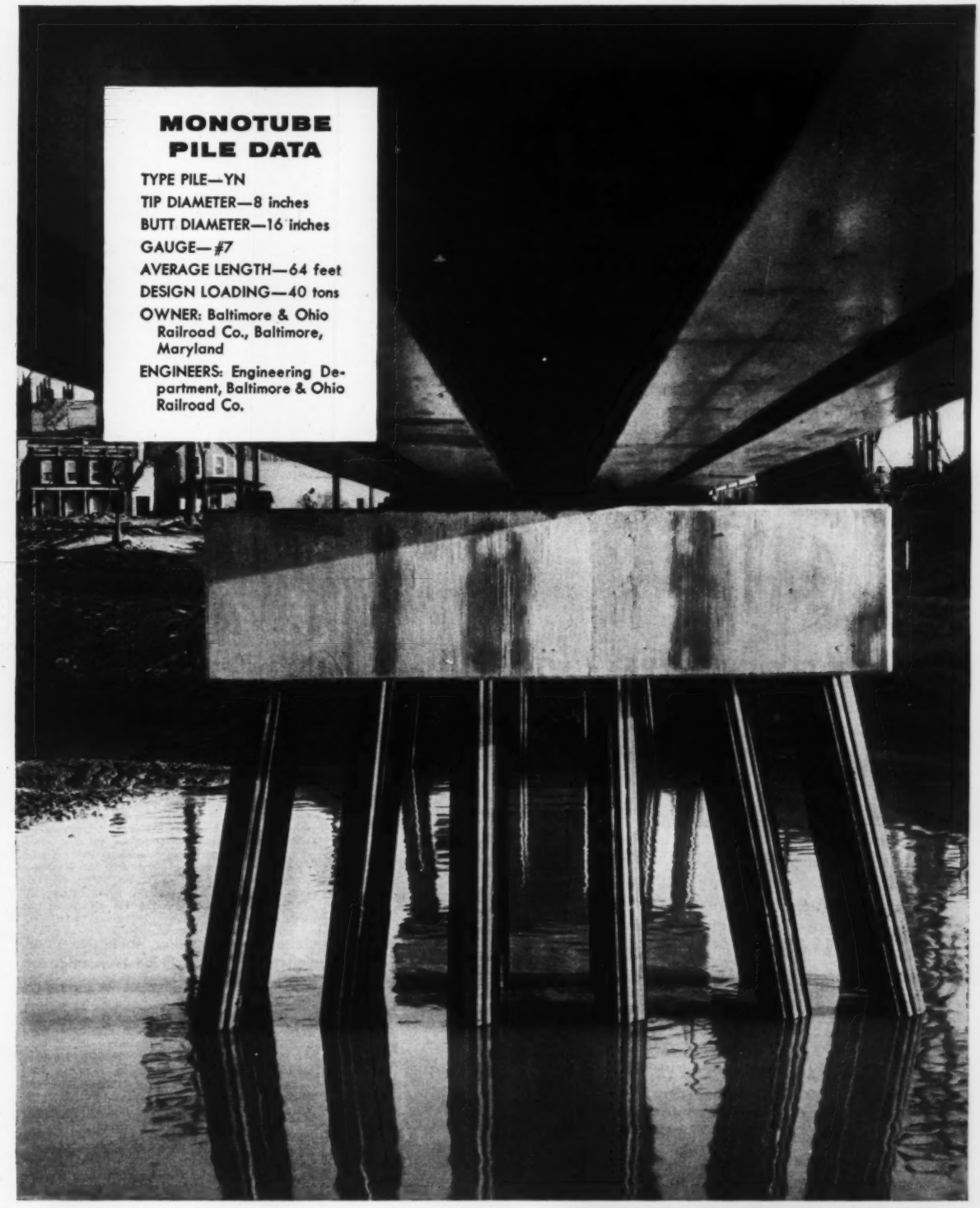
Chester Nelson Reitze (M. '16), age 73, president of the Superior Portland Cement Inc., Seattle, Wash., died recently. Mr. Reitze had been with Superior Portland Cement since 1925, for many years as vice-president and general manager. Earlier he was district engineer and Pacific Coast manager for the Portland Cement Association. He was graduated from Cornell University in 1905.

Jesse Wyman Shuman (M. '26), age 82, secretary-treasurer of the Power Engineering Company, Minneapolis, Minn., from 1904 until his retirement, died recently. Earlier in his career Mr. Shuman was connected with the Edwin P. Allis Company as local manager of their branch office in Minneapolis. He received a B.S. degree from Massachusetts Institute of Technology. Mr. Shuman was the author of numerous papers in ASCE Transactions and other technical journals.

Alex Alexander Sirel (A.M. '52), age 62, since 1944 assistant research engineer for the Engineering Structures Division of the Association of American Railroads, Chicago, Ill., died in Santa Barbara, Calif., on March 29. Earlier Mr. Sirel was engineering draftsman for the bridge department of the Chicago & Northwestern Railway Company. Mr. Sirel was a graduate of the South Dakota State School of Mines.

Alex A. Sirel

Edward Austin Tucker (M. '06), age 84, consulting engineer and specialist in building design and construction, Boston, Mass., died in February. As president and chief Engineer of the Edward A. Tucker Company from 1912 to 1929, Mr. Tucker was design and contracting engineer on a number of reinforced concrete installations. Later he was consulting and designing engineer for such notable projects as the Herald-Traveler plant in Boston, the U. S. Post Office in Portland Me., and the Court House in Ellsworth, Me. He was a graduate of the Massachusetts Institute of Technology.



DESIGN ECONOMY plus CONFIDENCE with Monotube piles . . . a sizable saving over conventional pier design, yet complete conformity with railroad specifications. That's the record of these Monotube piles used by the Baltimore & Ohio Railroad at Westport, Maryland.

Tapered, fluted Monotube piles are available in lengths, diameters and gauges to meet every requirement. Write The Union Metal Manufacturing Co., Canton 5, Ohio, for complete information.

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RECENT BOOKS

(Added to the Engineering Societies Library)

Bemessungsverfahren Fur Verbundtrager

In this book Günter Utescher presents a systematic method of determining correct cross sections for composite beams (concrete and steel), taking into consideration creep and shrinkage. The design is based on the German standards for such construction, including prestressed concrete, and design tables are appended for standard and wide-flange I beams. (1956, Springer-Verlag, Berlin, Germany. 39 pp., 24 plates. DM 12.00.)

Bridging The Years

A historical background by Charles M. Norrie of British civil engineering from the early 18th century to our present time, with accounts of great engineers and their accomplishments and influences upon society. The chapters include the development of the industrial age 1700-1825, the railway era 1825-1914, notable British civil engineering works 1825-1914, and the trend of events after 1914. A chronological listing of events and the men associated with them is provided in an appendix. (1956, St. Martin's Press, Inc., 103 Park Avenue, New York 17, N. Y. 212 pp., bound. $5.00.)

Building an Engineering Career

Third Edition, 1957

This is a text by Clement C. Williams and Erich A. Farber for an orientation course. The varied subject matter includes achievements in various fields of engineering; efficient study methods; and the nature of engineering thinking. For an overall view, a history of the engineering profession from the Egyptians to our twentieth century technology is presented, together with its ethics and cultural ideas. (McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 36, N. Y., 299 pp. $4.75.)

Building Cost Manual

This manual provides tabulated data contributed by more than 150 architects, engineers, builders, and manufacturers all over the U. S. Parts I and II give brief introductory information on cost data and their use, regional variations, and cubing instructions. In Part III 150 classified building types are illustrated photographically, each accompanied by a tabulation of structural elements and materials, mechanical equipment, and base costs. Photographic depictions of many older types are included with code numbers showing the nearest modern equivalent in each case for determining present replacement costs. Prepared under the direction of The Joint Committee on Building Costs, American Institute of Architects, Chicago Chapter and the Chicago Real Estate Board. (John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. 1957, 367 pp., bound. $15.00.)

Calculus Refresher For Technical Men

This refresher course by A. A. Klaf, gives a clear review of the subject by a simplified question and answer method. Altogether 542 problems are presented and solved. Included are limits, inverse functions, geometrical meaning of a differentiation, types of growth, exponential and logarithmical functions, partial differentiation, mean value, limits and areas and volumes by integration, center of gravity, moment of inertia, introduction to differential equations. There are 36 pages of formulas and tables and 182 figures. (Dover Publications, Inc., New York, 431 pp., $1.95.)

Clays and Clay Minerals

This conference—sponsored by the National Research Council and Pennsylvania State University—brought together engineers and scientists from such fields as soil mechanics, ceramics, mineralogy, and geology. The papers included in full in this volume deal with a wide range of subjects in these fields as well as in the fields of crystallography, soil physics, colloid chemistry, etc. Seven of the papers are reports from scientists from overseas on activities in clay mineralogy and technology outside the United States. (Proceedings of the Fourth National Conference, University Park, Pa., October 1955. National Research Council, Washington 25, D. C., 1956. Publication 456, 444 pp. Price not given.)

Collected Works of Theodore von Karman

4 Volumes

A tribute to Theodore von Kármán on his seventieth birthday, these volumes contain his works published from 1902-1952. Dr. von Kármán's early papers on the buckling of columns, the theory of plastic flow, strength theories, mechanism of fluid resistance, laminar and turbulent friction, stability of laminar flow, and theory of turbulence are all included. Dr. von Kármán has contributed to applied mathematics, physics, strength of materials, stress analysis, theory of elasticity, monocoque structures, vibrations, mechanics of fluids, turbulence, aerodynamics of aircraft and heat transfer. (Butterworths Scientific Publications, London, England, 1957. American Edition Published by Academic Press, Inc., 111 Fifth Avenue, New York 3, N. Y. $40.00.)

Dams For Hydroelectric Power In Italy

These six massive volumes contain descriptions, in English, of over one-hundred eighty dams in Italy and in neighboring areas ceded after the second world war. The descriptions in-

(Continued on page 116)

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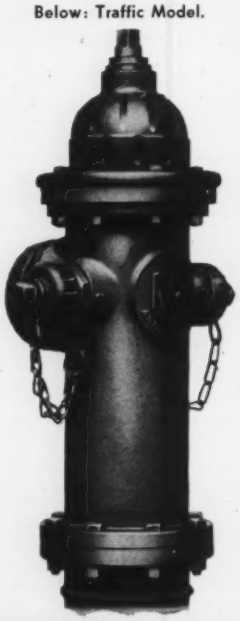
Below: Traffic Model.



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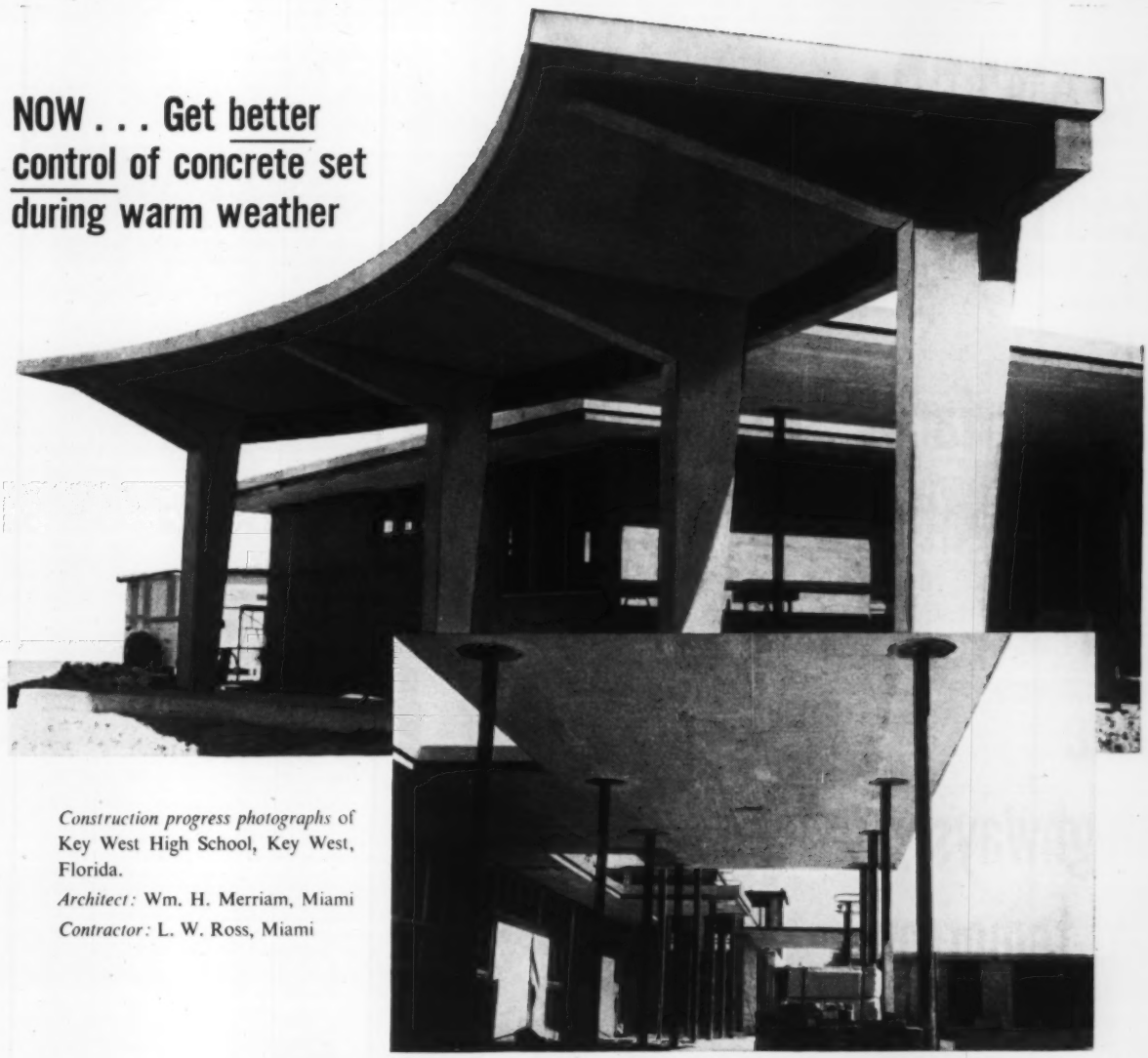

Construction progress photographs of Key West High School, Key West, Florida.
Architect: Wm. H. Merriam, Miami
Contractor: L. W. Ross, Miami

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Recent Books

(Continued from page 114)

clude data on construction principles and methods, the geology of the sites, and the behavior of the dams during operation. Maps, photographs, scale drawings, and sectionals illustrate the descriptions. The first volume of the set, not yet published in English, will contain technical data on various subjects connected with the planning and construction of dams in Italy. (Published 1952-1953 by the Associazione Nazionale Imprese Distributrici Di Energia Electtrica, Milan, Italy. Volumes 2-7, bound. Price not given.)

Engineering And Technical Handbook

This concise handbook by D. C. McNeese and A. L. Hoag is divided in five parts: basic formulas and fundamentals which may be applied to both engineering and physics; general information such as atomic weights and constants of the elements, strength of materials, coefficients of friction, and kinetic viscosity of various fluids; an alphabetical listing of units with their equivalents; mathematical computations ranging from arithmetic to integral calculus with illustrative examples; and the mathematical tables generally used in engineering and allied fields. (Prentice-Hall, Inc., Englewood Cliffs, N. J. 1957, 376 pp., bound. $6.00.)

Highway Research Board Proceedings

Thirty-Fifth Annual Meeting, January 1956.

The more than fifty papers in these proceedings are grouped by the various departments of the Board: Economics, Finance, and Administration; Design; Materials and Construction; Maintenance; Traffic and Operations; and Soils, Geology, and Foundations. A wide range of topics in these areas is discussed in the individual papers—financial planning, design of semi-flexible pavements, the strength of bituminous mixtures, bridge maintenance, television in traffic control, vibratory cutting of soils, etc. Edited by F. Burggraf and E. M. Ward. (National Research Council, 2101 Constitution Avenue, N. W., Washington 25, D. C. 1956, 840 pp., bound. Price not given.)

A History Of Technology, Vol. 2

The Mediterranean Civilizations and the Middle Ages.

This is the second volume of a series of five which will cover the development of technology from the Old Stone Age to the later 19th century. The first volume, already published, was from early times to the fall of ancient empires c.500 B.C. The present one covers the Mediterranean civilizations and the Middle Ages. Only the technology of Europe is dealt with, and the concern is mainly with the development of processes, techniques and devices rather than with social and economic implications. The range of subjects includes all those activities which provide for material needs: mining, quarrying, metallurgy, agriculture, leather, textiles, ceramics, glass, building construction, transportation, metal work, machinery, power, hydraulic engineering and sanitation. Six hundred ninety-five illustrations including maps and diagrams and an ad-

(Continued on page 118)

Library Services

Engineering Societies Library books may be borrowed by mail by ASCE members for a small handling charge. The Library also prepares bibliographies, maintains search and translations services, and can supply photoprint or microfilm copies of any items in its collection. Address inquiries to Ralph H. Phelps, Director, Engineering Societies Library, 29 West 39th Street, New York 18, N. Y.

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Recent Books

(Continued from page 116)

ditional 44 plates are provided. Literature sources are found at the end of each chapter, and personal and place name indexes are appended. Edited by Charles Singer and others. (Oxford University Press, 114 Fifth Avenue, New York 11, N. Y. 1956. 802 pp., bound. $26.90.)

Mathematics And Computers

A general introduction to computation methods and devices, intended to give to the non-specialist an understanding of basic concepts. Types of problems solved by computers, components and logical design of digital computers, analog computers and simulators, random numbers, numerical analysis, and applications are covered. (By G. R. Stibitz and J. A. Larrivee, 1957, McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 36, N. Y. 228 pp., bound. $5.00.)

Non-ASCE Meetings

American Institute of Chemical Engineers. Meeting at the Olympic Hotel in Seattle, Wash., June 9-12. Information from AIChE, 25 West 45th Street, New York 36, N. Y.

American Institute of Electrical Engineers. Summer general meeting at the Sheraton Mount Royal Hotel, Montreal, Quebec, June 24-28. Information from Charles E. Woolgar, Northern Electric Co., Ltd., 150 Metropolitan Blvd., Lachine, P. Q., Canada.

American Society for Engineering Education. Sixty-fifth annual meeting at Cornell University, Ithaca, N. Y., June 17-21. Information from W. Leighton Collins, Secretary, ASEE, University of Illinois, Urbana, Ill.

American Society of Mechanical Engineers. Semiannual meeting at the Sheraton-Palace Hotel, San Francisco, Calif., June 9-14. Information from K. B. Anderson, Pacific Gas and Electric Co., 245 Market Street, San Francisco 5, Calif.

American Society for Testing Materials. Annual meeting of ASTM at Chalfonte-Haddon Hall, Atlantic City, N. J., June 16-21. Information from ASTM, 1916 Race Street, Philadelphia 3, Pa.

Concrete Reinforcing Steel Institute. Thirty-third annual meeting at the Greenbrier, White Sulphur Springs, W. Va., June 24-29. Information from H. C. Delzell, 38 South Dearborn Street, Chicago 3, Ill.

Engineering Institute of Canada. Seventy-first annual general and professional meeting at the Banff Springs Hotel, Banff, Alberta, June 12-14. Information from the General Secretary, Engineering Institute of Canada, 2050 Mansfield Street, Montreal 2, Canada.

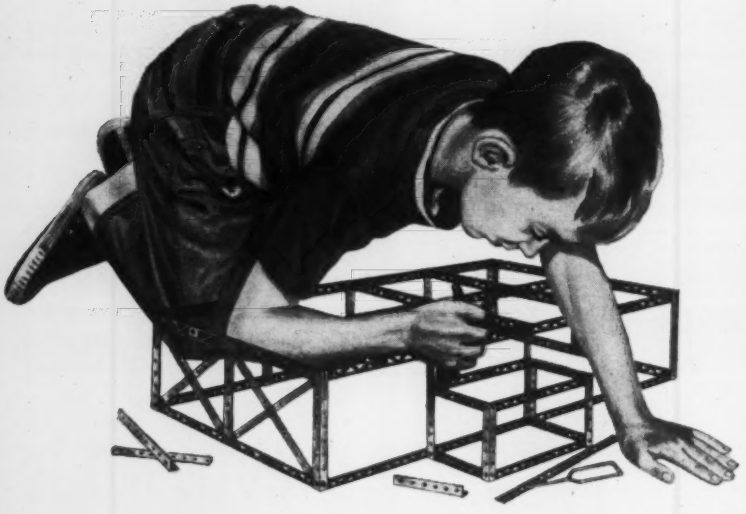
Institute of Traffic Engineers. Meeting of Western Section at the Cosmopolitan Hotel, Denver, Colo., June 25-27. Information from John A. Bruce, City and County Building, Denver 2, Colo.

International Association of Navigation Congresses. Nineteenth International Navigation Congress in London, England, July 8-16. Information from Col. G. W. Carlson, Board of Engineers for Rivers & Harbors, Washington 25, D. C.

Radiological Safety Conference. At Canisius College, Buffalo, N. Y., June 12-14. Information from Director of Public Relations, Canisius College, Buffalo 8, N. Y.

University of California. World Conference on Prestressed Concrete at the Fairmont Hotel, San Francisco, Calif., July 29-August 2. Information from the Department of Conferences and Special Activities, University Extension, University of California, Berkeley 4, Calif.

Wire Reinforcement Institute Inc. Annual spring meeting at the Greenbrier, White Sulphur Springs, W. Va., June 24 and 25. Information from Frank B. Brown, WRI, National Press Building, Washington 4, D. C.



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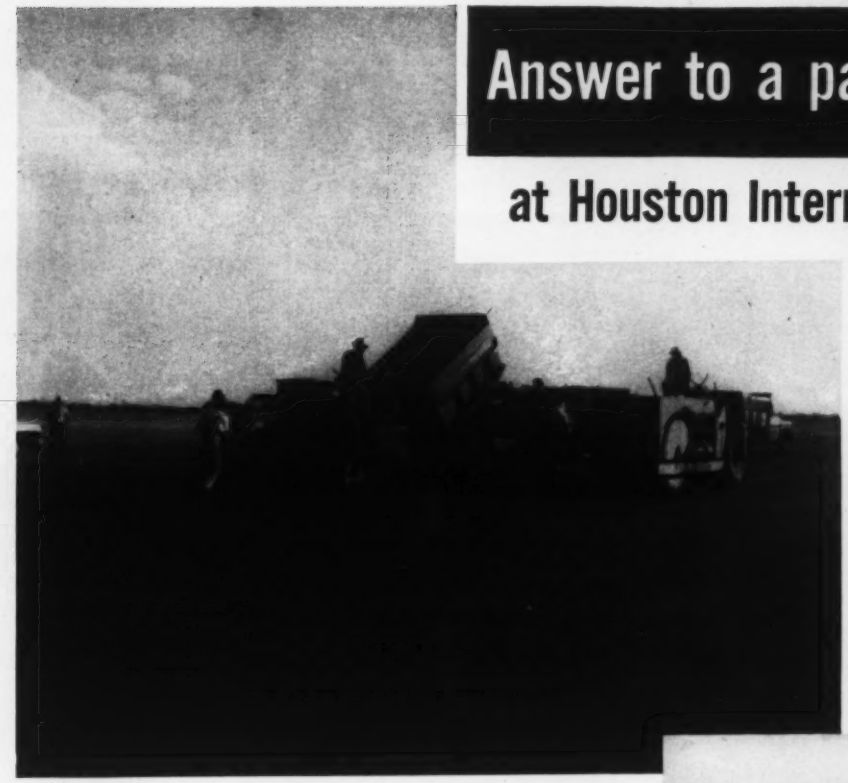
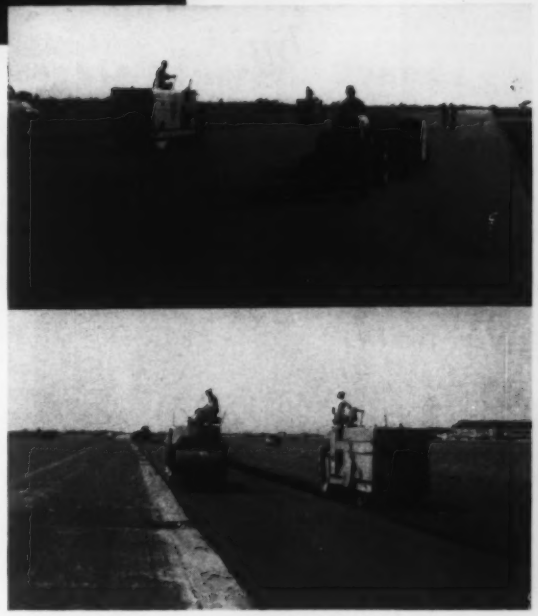


Photographs

(left) Laying initial course of 1-inch Texaco Sheet Asphalt on instrument runway of Houston International Airport.

(center) Rubber-tired and tandem rollers were used to compact Sheet Asphalt course.

(bottom) Constructing 3-inch coarse-graded Texaco Asphaltic Concrete binder course.



One of the nation's busiest air fields, Houston International Airport was confronted with the deterioration of 155,000 square yards of rigid type pavement on runways and taxiways. How to provide this large area with durable, economical paving, while subjecting plane traffic to a minimum of inconvenience, was the problem.

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Houston International Airport's Texaco-paved runways and taxiways combine rugged durability under heaviest air field traffic with a high degree of skid-resistance. Both initial cost and upkeep cost are lower than for comparable rigid paving. Snow melts more rapidly on a dark asphalt surface, an important advantage in many parts of the country.

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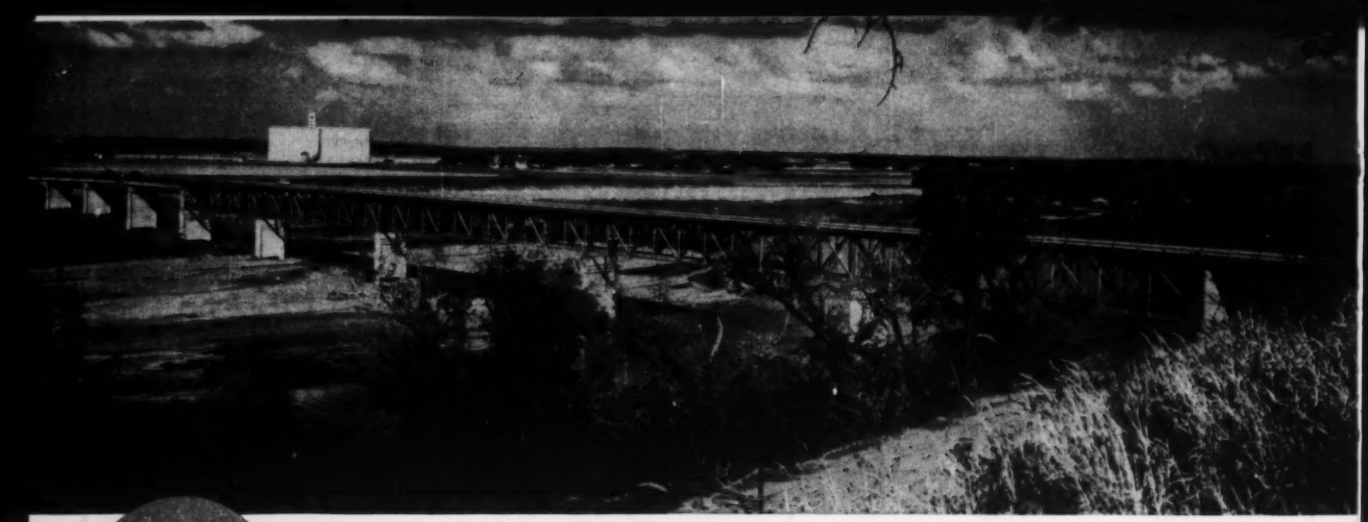

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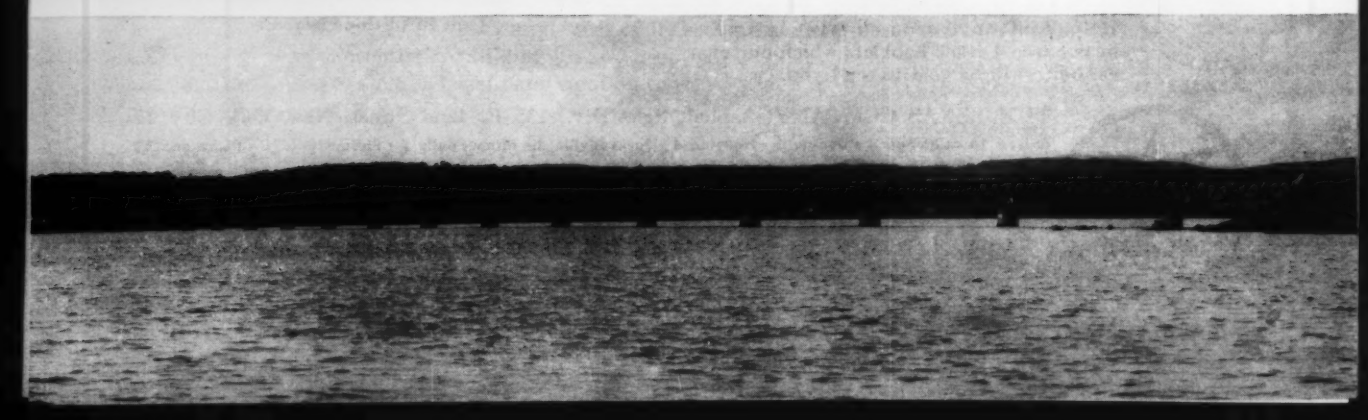
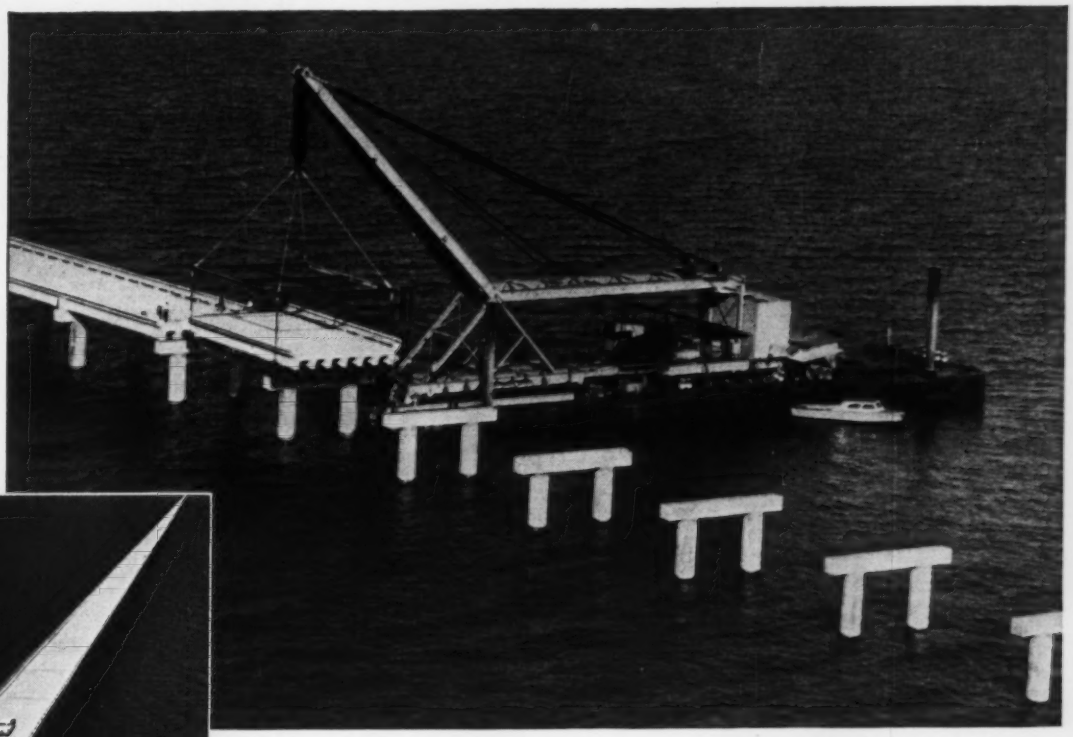
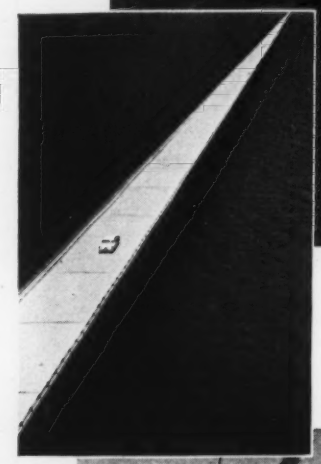
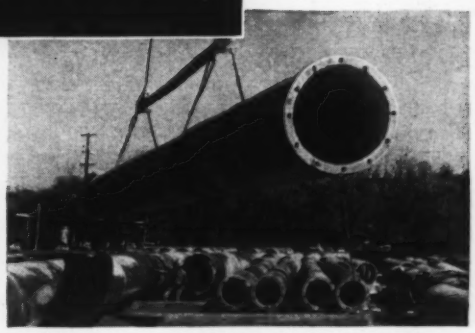


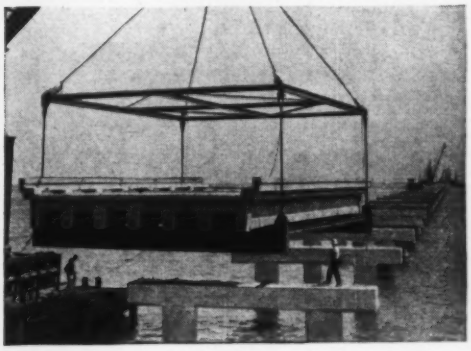




Prestressed, Precast Concrete Speeds Building of Lake Pontchartrain Bridge



Above, a few of the 4,886 prestressed concrete piles used on the Lake Pontchartrain Causeway. Below, one of the 2,246 prestressed, precast concrete bridge spans.



The world's longest overwater highway bridge, the 24-mile Lake Pontchartrain Causeway was to be constructed in 23 months. This was a difficult contract by any method of building. By employing precast concrete units the job was completed four months ahead of schedule.

The early completion of this tremendous job was made possible by employing mass-production, assembly-line techniques and by designing the structure so that only three basic types of precast concrete units were required. These were (1) hollow cylindrical prestressed piles, 54-in. dia. and averaging 88 ft. in length, (2) precast reinforced concrete pile caps and (3) prestressed, precast concrete deck spans each 56-ft. long and 33-ft. wide.

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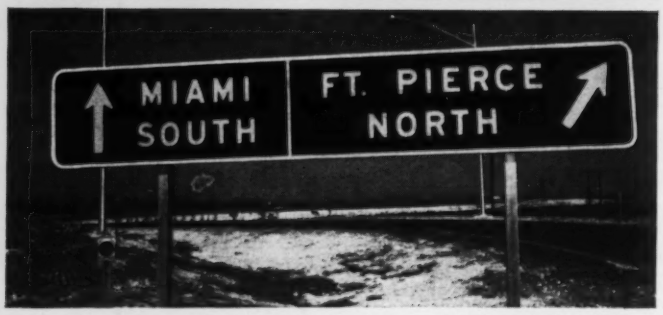

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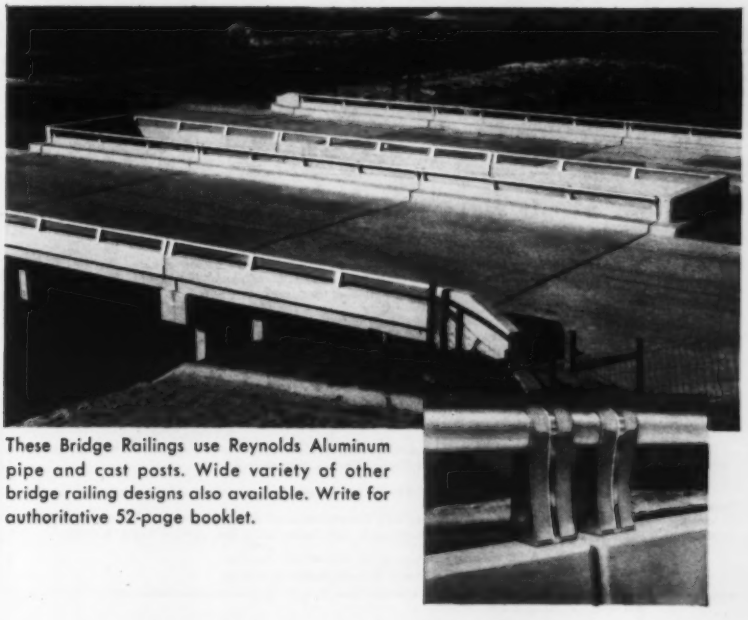

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FIELD OFFICE ENGINEER, A.M. ASCE; M.S.C.E., Purdue University, 1955; 35; thoroughly grounded in structural engineering theory and practice; 6 years' design experience with consultants in United States. American citizen. B.S.C.E., University of Vienna. Knows French, German, Yugoslavian languages. Single. Desires position in South America or Europe. C-217-778-San Francisco.

PLANT OR FACILITIES ENGINEERING MANAGER, M. ASCE; member of American Management Association; 48; B.C.E.; registered, New York, Michigan and Rhode Island. Manager of plant engineering for multi-plant corporation for past 8 years with heavy experience on new plant design and major alterations; 25 years' experience on technical administration in staff capacity on project design and construction. Available June. C-218.

ENGINEER, A.M. ASCE; B.Sc. (London); 33; 3 years' civil engineering design, specifications, contract administration: Industrial buildings, power plants, paper mills; 6 years in all aspects of civil construction with contractor; 3 years' mechanical marine operations and maintenance (Navy). Flair for writing. Location desired, New York City. C-219.

STRUCTURAL OR SANITARY ENGINEER, A.M. ASCE; B.S.C.E., M.S.E.; 34; sanitary engineer director for 4 years; water supply and sewerage design; municipal sanitation, etc. Commissioner of public works for 2 years, structural design, sewerage, water supply, contracts, administration, etc. Location desired, anywhere in United States or foreign. C-220.

EXECUTIVE ENGINEER, M. ASCE; C.E.; 47; registered professional engineer; 29 years' experience in construction and design management (also maintenance) of large-scale structures and utilities (all types). No preference as to location. C-221.

CIVIL ENGINEER, J.M. ASCE; B.C.E., 26; P.E. Experience in municipal and sanitary engineering, including 2½ years' active duty as maintenance and utilities officer, 1 year graduate study in sanitary engineering, and 1 year as city engineer in town of 16,000. Desires position with responsible consulting sanitary engineering firm. Location desired Southeast or West Coast. C-222.

CIVIL ENGINEER, J.M. ASCE; M.S.C.E.; 26; married; 3 years' diversified construction experience; 2 years' commissioned overseas service, supervisor of 22 design engineers, responsiible for construction valued at over $1.5 million. Interested in position utilizing structural or soil mechanics background. Location open. Available in July. C-223.

CIVIL ENGINEER, J.M. ASCE; B.S.C.E.; 24; married; 1½ years' varied design experience, 3 months' field work on highway inspection. Location desired, small city in Midwest. C-224.

FIELD OR ADMINISTRATION ENGINEERING, A.M. ASCE; 69; retired chief, engineering branch, U. S. Corps of Engineers, with 40 years' construction experience in California, Mexico, and South America, desires suitable job in engineering or construction. Can design, check, and administer projects. Speaks Spanish, and Italian. C-225-776-San Francisco.

CIVIL ENGINEER (Utilities), J.M. ASCE; B.S.-C.E.; 31; married; 3 years' engineering department of major railroad; 3 years' supervisory position on construction of steam power plants. Location desired, southern United States. C-226-806-Chicago.

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(Continued on page 126)

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(Continued from page 127)

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Army Corps of Engineers. There are openings for engineers at the U. S. Army Engineer Center, Fort Belvoir, Va., under the classification: Bridge Engineer, GS-7, 9, 11, salary from $5,335 to $7,035 per year, and Civil Engineer GS-5, 7, 9, 11, salary from $4,480 to $7,035. Obtain application Standard Form 57, from any Civil Service or Department of the Army Civilian Personnel Office. Mail to Civilian Personnel Office, Employment Division, Room 200A, Building 211, 21st Street, U. S. Army Engineer Center, Fort Belvoir, Va.

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Certainly you'll want to learn of the specific opportunities available to you. To apply, send resume of your education and experience to Engineering Personnel, Room 1068, Western Electric Co., 195 Broadway, New York 7, N. Y. In confidence, if you wish.

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Applications for Admission to ASCE— March 30—April 27, 1957

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WARREN FRANCIS BAKER, Boston, Mass.
CARL JACOB BROWNE, Balboa Heights, Canal Zone.
WILLIAM KELLER CLAYTON, Harrisburg, Pa.
JOHN BURHYTE WILMOT COREY, JR., Chicago, Ill.
RICHARD LILE CRAWFORD, Guatemala City, Guatemala.
MINOR EYONE DEAN, Jackson, Miss.
GEORGES DEMERS, Quebec, P.Q., Canada.
JULIUS DORFMAN, Philadelphia, Pa.
ELLSWORTH BARRICKLOW DOWNING, Memphis, Tenn.
MAHMOUD MOHAMED GADEIN, Blue Nile Province, Sudan.
JOHN HORTON, Oklahoma City, Okla.
CARL EDWARD JACOBSON, College Park, Ga.
JAMES CARLTON KEY, Roanoke, Va.
THEODORE HERMAN KRUTTSCHNITT, JR., Burlingame, Calif.
FULTON SHERMAN MILLS, Jackson, Miss.
XENOPHON DUKE MURDEN, Portsmouth, Va.
DONALD NEWTON, Chicago, Ill.
HENRY FRANK PETERSON, Richland, Wash.
ANDREW RETI, Caracas, Venezuela.
WILLIAM JOSEPH SANTINA, Chicago, Ill.
HERMAN KENNETH SCHRAMM, Frederick, Md.
ROBERT SCHUMACHER, Brooklyn, N. Y.
ROBERT EDWARD SMITH, Boise, Idaho.
KAARE SOLNORDAL, Kopperaa, Norway.
KAN VATANMAL THADANEY, Madras, India.
FRANK COLES VAUGHAN, Richmond, Va.
EUGENE BENJAMIN WAGGONER, Wheat Ridge, Colo.
JOHN HENRY WELLS, Melrose, Mass.
JOHN HARRY WILSON, San Mateo, Calif.

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EDWIN LEON ANTHONY, Rochester, N. Y.
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BEN DANIEL ATCHLEY, SR., Shreveport, La.
HEINZ JOACHIM BECKER, Cochabamba, Bolivia.
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HAROLD EDSON GREENWOOD, Rolla, Mo.
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JACK WILLIAM HIND, Knoxville, Tenn.
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PETER BRYAN ROSCOE JOHNSON, Ankara, Turkey.
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WILBUR JAMES WIDMER, Storrs, Conn.
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The 110'6" debutanizer shown above and the 150-ton unit (below), a 3-stage axial flow compressor. are typical Newport News products. Whether you need a hydraulic turbine, vacuum tanks or penstocks . . . bridge caissons, digesters or dryer rolls . . . you can command the services of Newport News for units of about any size or shape.

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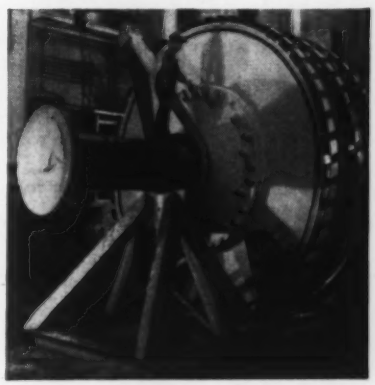
Moreover, Newport News' plant provides unsurpassed facilities. More than 225 acres in area, it comprises vast steel fabricating shops, five huge machine shops, acres of pattern shops and foundries. It includes forge and die shops, heat treating furnaces and allied equipment, along with complete modern test apparatus.

But most important of all . . . it is the high integration of skill and production facilities that enables Newport News to build large units fast . . . to save valuable time. Let us bid on your present or future projects. Write today for your copy of our illustrated booklet "Facilities and Products."



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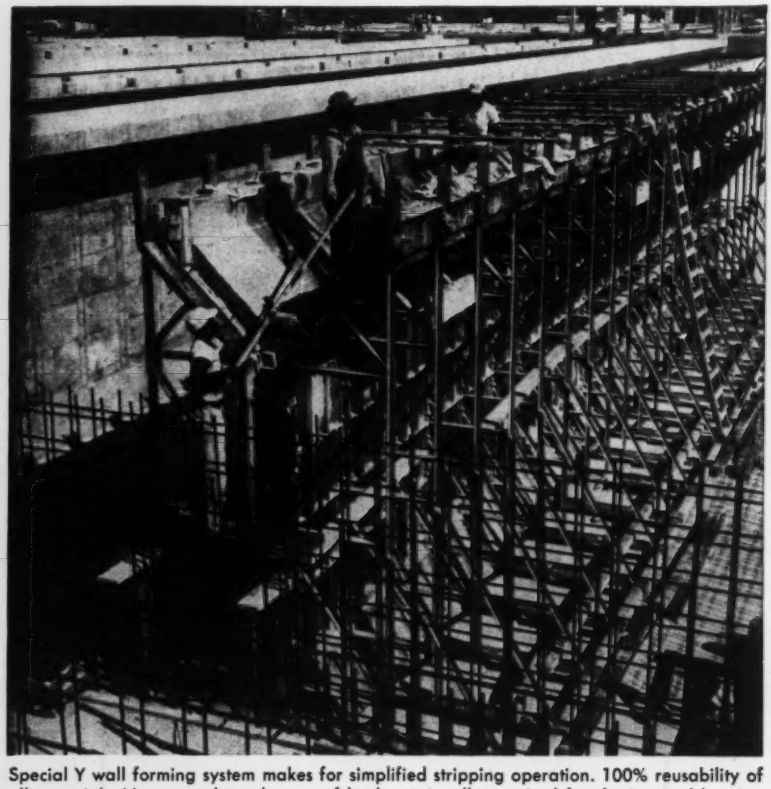
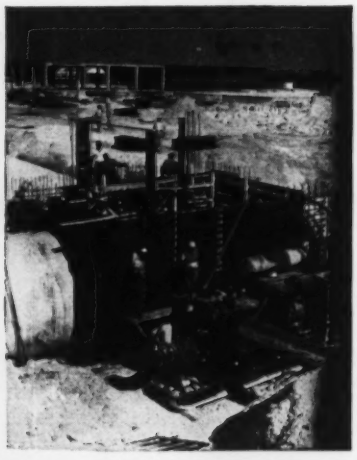
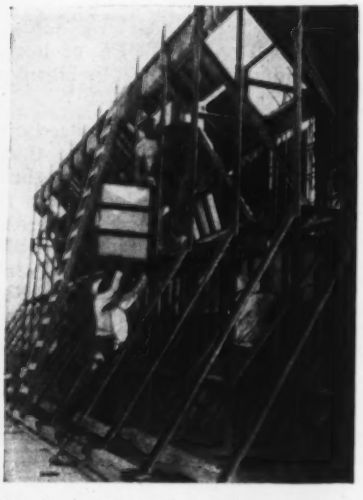


Special Y wall forming system makes for simplified stripping operation. 100% reusability of all materials. Note complete absence of lumber normally required for shoring and bracing on this type of structure.



Intricate forming in restricted areas presented no problem. Uni-Form Panels erected aligned and braced one side eliminated difficulties normally encountered in placement of reinforcing steel. Note Uni-Form Panels around large precast pipe.

One side aligning and bracing provides clear unobstructed working areas increasing job efficiency.



Y wall trusses incorporated alignment, bracing, shoring and scaffolding requirements.

CUTS MATERIAL COSTS with Pre-Fab Form System on Sewage Plant Job

In the construction of the Miami Sewage Treatment Plant Job the Paul Smith Construction Co., of Miami, Florida chose to use the Uni-Form Panel System in the forming of one million sq. ft. of contact area. The contractor estimated that the use of the Uni-Form System *saved 40 percent in material costs alone.* In addition, faster form erection with fewer men kept the job moving ahead of schedule and reduced estimated labor costs considerably. These fine results were obtained even though this was the contractor's first experience with the Uni-Form Panel System.

This considerable savings in material and labor was realized in spite of intricate Y wall forming and pipe intersections which causes complicated forming problems with conventional forming systems.

Pre-fabricated, ready to use—completely engineered to handle most forming problems, the Uni-Form Panel System provides such advantages as simple assembly — minimum one side alignment and bracing —automatically accurate wall widths—positive internal spreading — faster stripping and maximum re-usage to give the contractor lowest all around form costs.

Y wall trusses designed to member with standard Uni-Form Panels formed a completely automatic system for handling the special forming problems, and were big factors in the economy and speed obtained on the job. Simple assembly of Standard Uni-Form Panels on the trusses eliminated many of the aligning, bracing and spreading problems usually encountered in Y wall construction. In addition to simplified forming the combination system of standard Uni-Form Panels and trusses eliminated many of the problems normally encountered in the stripping of a wall section of this type. The contractor was well pleased with all phases of his forming and stripping operations.

Why not investigate the many advantages the Uni-Form Panel System can bring to you? Write for the Uni-Form Catalog — or better yet, send us a set of plans for an estimate on your next job. Let us prove to you as we did to the Paul Smith Construction Co., that the Uni-Form Panel System can cut your forming costs.

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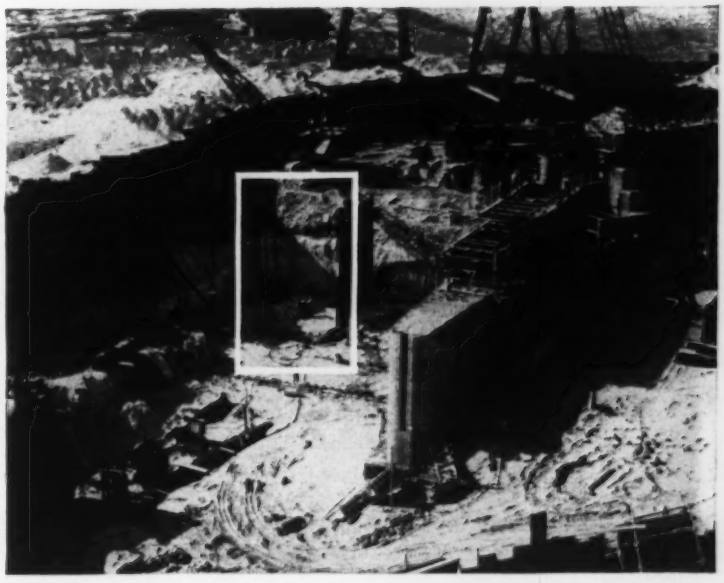

"STANG *DID IT!"*

Holding back the mighty Mississippi is a king-sized job anytime, but it posed a particularly tough problem on the St. Anthony Falls Lock and Dam project.

The job called for dewatering and support of a crumbly, porous sandstone material on the very edge of the river and immediately adjacent to the cellular cofferdam. The prime contractors Johnson-Kiewit, together with the U.S. Army Engineers supervising the project, made a daring decision. They called for Stang wellpoints to eliminate the serious piping which developed from the river, under the cellular cofferdam and on into the excavation area.

They banked on Stang's versatility and it paid off. The wellpoint installation was highly successful; not only eliminating the piping condition, but actually lowering the water table below the deepest subgrades.

Call on STANG engineers for experienced services and special equipment to solve your water handling problems—any size, any type, *anywhere!* STANG engineers are on call in your area for consultation day or night.

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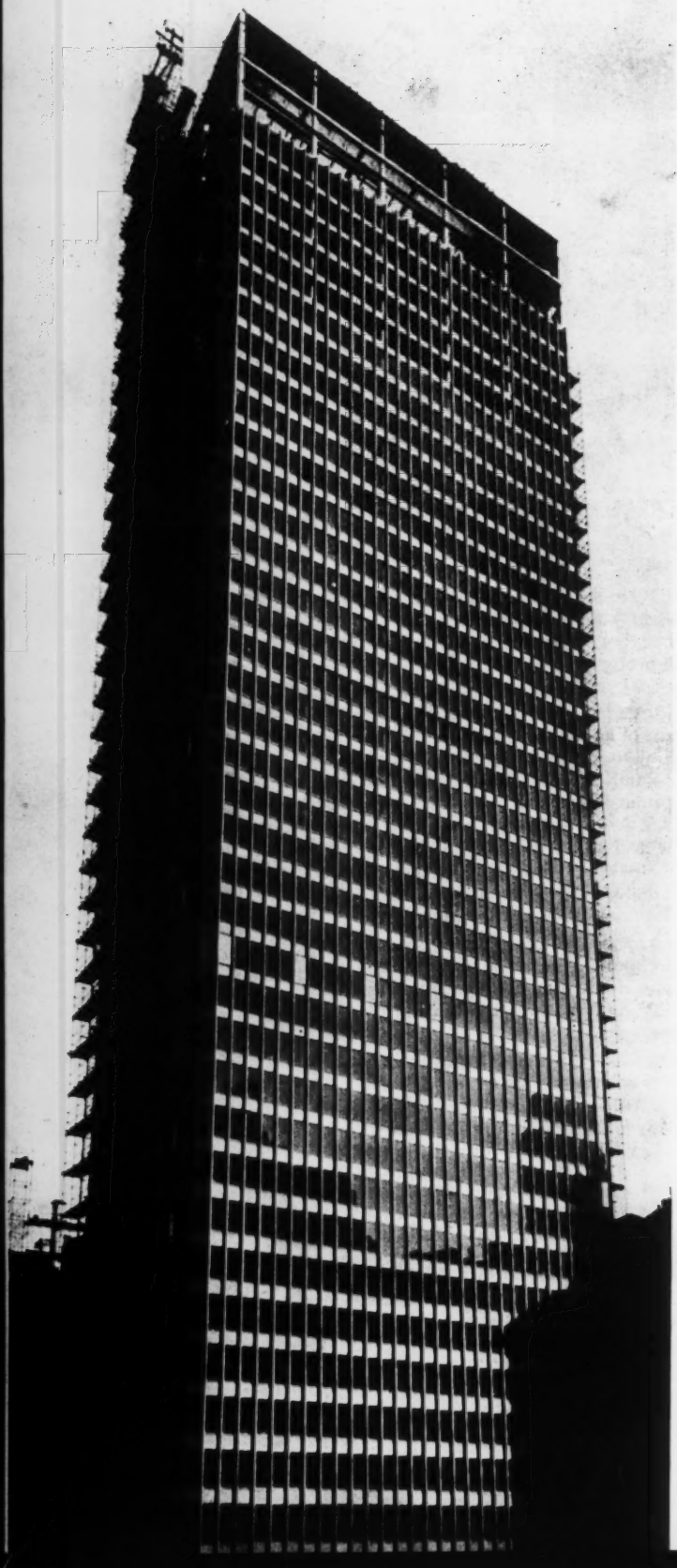
Putting water in its place ...anyplace!



38 stories high -and it's bolted!

You're looking at the 38-story Seagram Building, at 375 Park Avenue, New York—presently the nation's tallest office building to employ high-strength bolting. The bronze-clad beauty, trimmed with tinted glass, occupies the blockfront between 52nd and 53rd Streets. Approximately 190,000 Bethlehem High-Strength Bolts were used in joining the structural members of its 13,447-ton steel framework.

With Bethlehem High-Strength Bolts so easy to install, the erection of the steelwork was completed in slightly less than six months of actual working time. Moreover, because of the lack of construction noise, as compared with riveting, the structure was recipient of New York's "Quiet City Award.'

Bethlehem High-Strength Bolts save erection time because they can be installed quickly with a holding wrench and a pneumatic impact wrench. They provide joints which are permanently tight. They also promote safety as there's no fire hazard involved, nor any danger of injury from tossed rivets.

Bethlehem High-Strength Bolts are made of carbon steel. They are heat-treated by quenching and tempering, and meet every requirement of ASTM Specification A-325.

If you have any question about Bethlehem High-Strength Bolts, feel free to call the nearest Bethlehem sales office. Or if more convenient, drop a line to us at Bethlehem, Pa.

Architects: Mies van der Rohe and Philip Johnson, Associate Architects: Kahn & Jacobs; Structural Engineers: Severud-Elstad-Krueger; Mechanical Engineers. Jaros, Baum & Bolles; General Contractor: George A Fuller Company; Renting and Managing Agent: Cushman and Wakefield.

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BETHLEHEM STEEL

Leffel Turbines Help Provide New Power for Puerto Rico

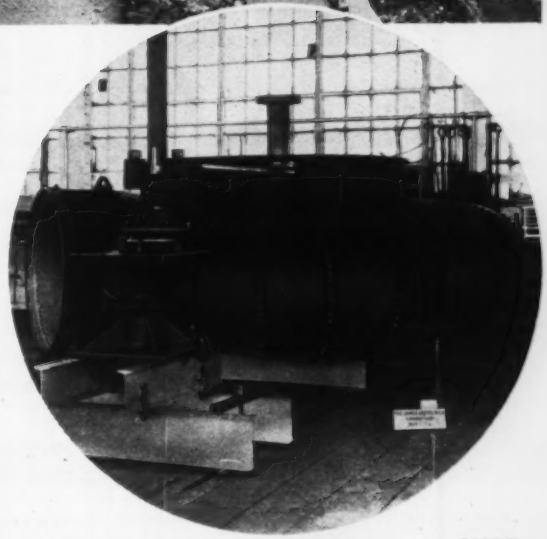
Rio Grande De Loiza Dam, a project of the Puerto Rico Aqueduct and Sewer Authority

At the new power plant at the Rio Grande De Loiza Dam, dependable Leffel turbines drive the generating units. Located at Trujillo Alto in San Juan's metropolitan zone, this project was constructed for adequate public water supply and hydroelectric power generation. It includes, in addition to the dam and hydroelectric plant, a filter plant and an extensive sanitation system.

Each of the three Leffel turbines in this station is rated to develop 1550 HP under 68 foot net head, speed 327 RPM. The view above shows the completed Rio Grande De Loiza Dam and hydroelectric plant. The view at the right shows one of the three plate steel spiral case turbine units being completed on the assembly floor of the factory.

Leffel turbines are dependably and efficiently harnessing water power all over the world as they are in Puerto Rico. Leffel designs and builds equipment for maximum reliability and efficiency — Leffel turbines last longer and do a better job because they're heavier and more rugged.

Leffel has been producing hydraulic equipment of the finest caliber since 1862. Before you plan your next turbine installation, whether it's completely new or the rehabilitation or expansion of present facilities write for the complete story. Our experienced engineers are ready to put their "know how" at your disposal . . . no obligation.



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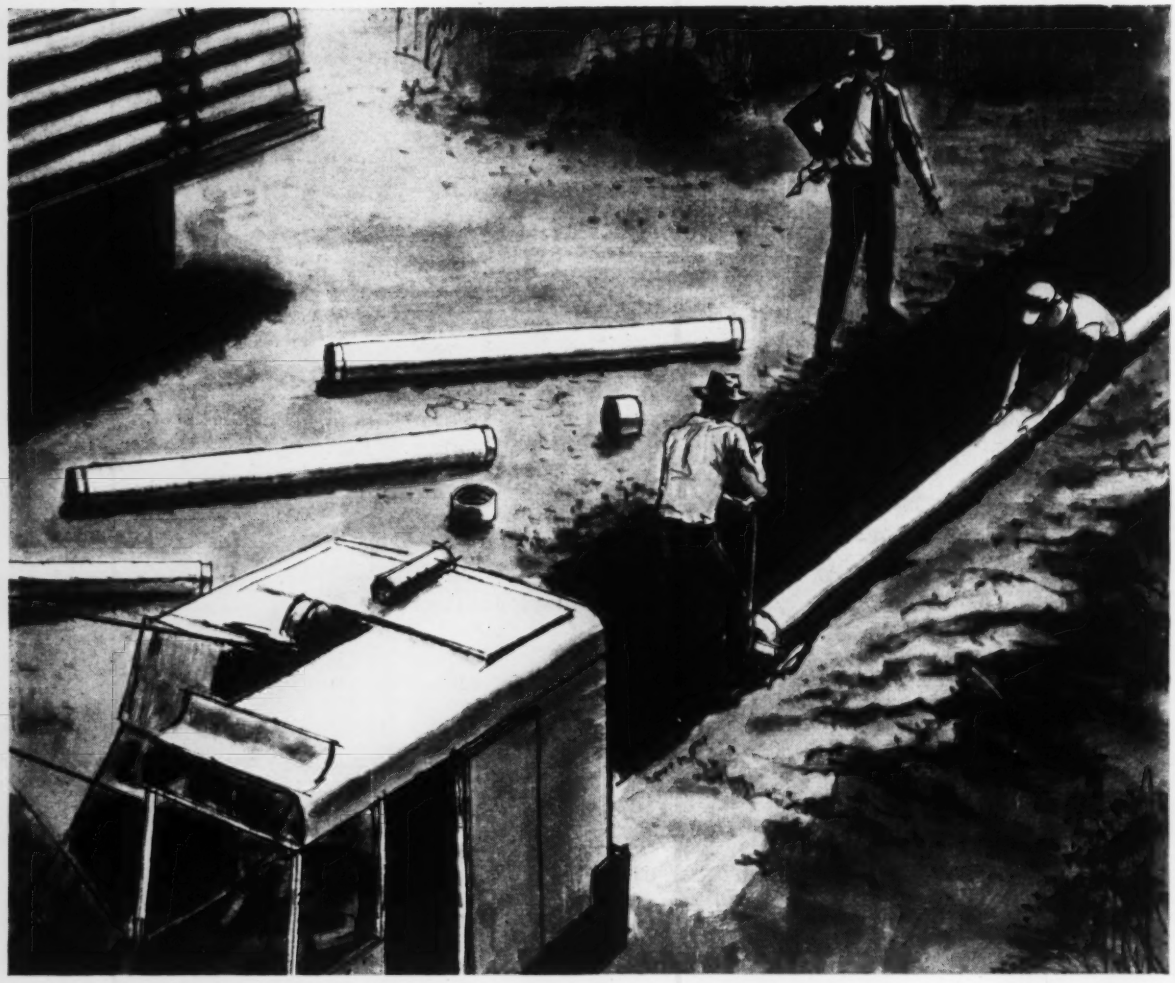
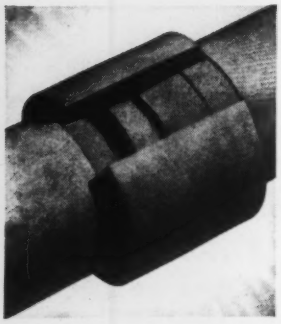


The job moves along fast
with Transite and the Ring-Tite Coupling!



Sectional view of Ring-Tite Coupling. Ring is cut away to show how rings are compressed and locked in grooves—*a tight, lasting seal!*

Transite Pressure Pipe is lightweight and easy-to-handle . . . quickly assembled with the Ring-Tite Coupling!

With Transite® Pipe, installation crews move along fast! So fast, they consistently keep up with the excavator—installing pipe as rapidly as the trench can be opened.

Ease of handling and simplified assembly explain these advantages. Light in weight, Transite is easier to truck, easier to handle on the job. With the Ring-Tite® Coupling only simplest tools are needed for joining—pipe ends are automatically positioned within the coupling to allow for expansion.

So save while you assure your community of top economy, long trouble-free performance with Transite. For its smooth interior (flow coefficient is C=140) *often* permits selection of smaller diameter pipe . . . *always* keeps pumping costs low. And since Transite can't tuberculate, water systems can be designed without allowing for future flow reduction caused by that form of interior corrosion.

Let us send you further information on Transite asbestos-cement Pressure Pipe and the Ring-Tite Coupling. Write for booklet, TR-160A, Johns-Manville, Box 14, New York 16, N. Y. In Canada, Port Credit, Ontario.

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On your next bridge or overpass, design for rugged beauty plus economy . . . design for REINFORCED CONCRETE.

Overcrossing located in downtown Los Angeles carrying local city traffic across the Harbor Freeway, U.S. Highway 6.

Designed by the California Division of Highways

Contractor: Winston Bros., Monrovia, California

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New Type Shovel-Crane

AN ENTIRELY NEW TYPE OF construction tool, fully convertible to shovel, crane, clamshell, drag and hoe, the model SP-107, is a self-propelled machine mounted on a short-coupled, square rubber-tire carrier with 4-wheel drive. It requires no outriggers to develop a full-rated 7-ton lifting capacity in all positions of turntable swing.

Four-wheel drive is provided on the SP-107 along with hydraulic power steering of the wheels on one axle. Optional equipment provides for hydraulic power steering of all 4 wheels, in which case the wheels on either axle may be steered independently of those on the other axle to provide a close-quarter 15-ft turning radius, or wheels may be positioned in the same direction to permit the machine to "crab" sideways.

The power-take-off on the turntable is through an automatic transmission and torque converter. This, coupled with the single speed transfer case on the carrier, provides 3 travel speeds in both directions up to 15-mph. For digging operations where additional tractive effort and off-the-highway travel are desirable, a simple modification to the transfer case permits the addition of 3 additional speeds in the lower ranges.

The independent travel provides for traveling, hoisting, swinging, and boom derricking simultaneously with each under separate clutch control. The 2 clutches for controlling forward and reverse independent travel are duplicates of the hydraulic clutches used elsewhere throughout the machine. **The Thew Shovel Co., CE 6-138, Lorain, Ohio.**

Pocket Altimeter-Barometer "Thommen"

IMPROVED AND MORE ACCURATE than the previous model of Pocket Altimeter-Barometer "Thommen," types 3D15 and 3D17 are manufactured by a Swiss firm that has had technical experience in the manufacturing of precision instruments for over 100-yr.

The main feature of the instrument is its easily readable scale which is graduated to 50-ft but can be estimated to 10-ft.

No mistake can arise from the influence of the temperature and the rigidity and dilation of the aneroid case, as the instrument is compensated.

Generally the altitude indicated is all the more accurate because the difference in altitude has been covered more rapidly and the temperature of the instrument is lower.

Through a special kind of mechanism it is possible for the scale to be absolutely linear over the whole measuring range of the instrument and eliminate the difficulty which one encounters in reading the scales of other instruments in higher altitudes.

The inner scales show the dial for the barometer. Every 3000-ft indicates a different color and one should read the scale having the same color as the one in the little oval. **William Wolff, CE 6-138, 4051 Maybelle Ave., Oakland 19, Calif.**

Volumeter

THE PUBLIC IS NOW BEING offered an improved Volumeter, Model VM 500A, which is being used successfully in many State Highway Departments and Universities. This versatile instrument may be used to make rapid and accurate determinations of specific gravity, moisture content, density, etc. as well as performing other useful service in research work.

The overall dimensions of the instrument are approximately 7-in. outside dia by 14½-in. high and its weight is 20-lb. The gross weight of the instrument and accessories in the fitted box is 37-lb. The sample chamber dimensions are 3-in. inside dia by approximately 7 3/16-in. deep.

A special instrument Model VM 500B designed for testing densities of 4-in. dia asphaltic concrete cover has been manufactured with a sample chamber measuring 4-in. inside dia by approximately 6½-in. deep. **D. Ballauf Mfg. Co., Inc., CE 6-138, 619-21 H Street, N.W., Washington 1, D. C.**

Three Bolts Can Do the Work of Four

THREE BOLTS POSITIONED 120-deg apart around a common center will provide as stable a joint as the conventional pattern of four bolts arranged symmetrically, according to their manufacturer.

Savings in assembly—made possible by fewer holes to drill and fill—make the three-bolt joint more desirable.

In terms of holding power, the stronger the bolt, the less it costs. RB&W engineers calculate that a dollar's worth of holding power in high tensile bolts costs $1.50 when bright cap screws are used and $1.65 with machine bolts.

High tensile bolts, identified by three radial dashes on the bolt head, have a high carbon content and are heat treated to increase strength. They are rated at 120,000-psi tensile strength.

Bright cap screws, identified by their bright finish, are produced to rigid dimensional tolerance and are rated at 68,000-psi. **Russell, Burdsall & Ward Bolt & Nut Co., CE 6-138, Port Chester, N. Y.**

Hydro-Fog

ACCORDING TO THE MANUFACTURER, the use of Hydro-Fog, a new, power-driven unit designed primarily for spraying concrete forms, saves man hours as it permits spraying assembled forms in an average basement foundation in less than 15-min. The unit has a safety factor, too. The operator has only the hose and a 3-ft spray tube to handle, rather than to carry a bulky, off-balance pack while catwalking over forms. The 60-ft of hose provided also permits the operator to cover a complete foundation without having to continually relocate the unit.

A self-contained, compact unit, Hydro-Fog is complete with power supply, fluid tank and 60-ft of hose. A hand-operated hose reel is optional. Pressure up to 300-psi, comes from a 72-gph self-priming Sundstrand pump driven by a 2-hp Clinton Gasoline engine. A pump by-pass permits nozzle shut-off without damaging pump or engine. The tank, 30-gal capacity, is heavy gauge welded steel, and has full length handles on both sides to facilitate carrying. **Hydro-Fog Equipment- Co., CE 6-138, 2500 North Main St., Rockford, Ill.**

170 Miles of Armco Piling used on New York Thruway

Along the 425-mile New York Thruway from New York City to Buffalo, and the 70-mile extension from Buffalo to Erie, contractors have driven nearly 900,000 feet of Armco Piling as foundations for bridges and underpasses.

Leading engineers and contractors throughout the country have also selected Armco Piling and other Armco Construction Products for use on major highways such as the Pennsylvania Turnpike, Garden State Parkway, Indiana Toll Road, Kansas Turnpike, Turner Turnpike, and many others.

There is a size and type of Armco Product to help you solve almost any drainage or construction problem. Write us for helpful, authoritative data. Armco Drainage & Metal Products, Inc., 5107 Curtis Street, Middletown, Ohio. Subsidiary of Armco Steel Corporation. In Canada: write Guelph, Ontario. Export: The Armco International Corporation.

Armco HEL-COR Pile Shell being driven for overpass on Buffalo-Erie extension of New York Thruway.

ARMCO CONSTRUCTION PRODUCTS

EQUIPMENT, MATERIALS and METHODS

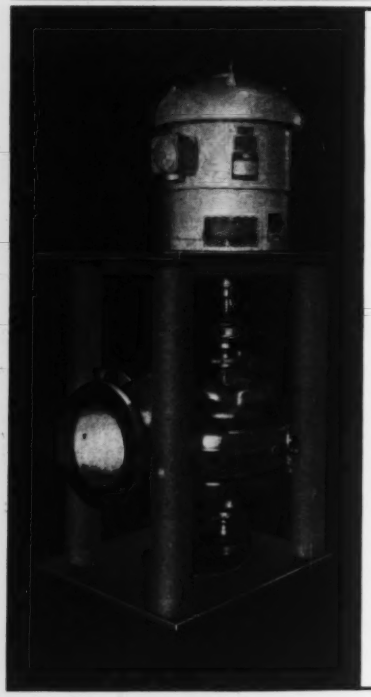
(continued)

New Repair Link

A NEW, EASY-TO-INSTALL "missing link" for repairing hoist and drag chains has been developed. The Kensington link is notable because of its simplicity and the ease with which it can be assembled. It consists of two identical half links and a combination key and wedge.

The half links are inserted through the ends of the chain to be joined; then when the wedge is driven into place, it automatically bends the key and thus locks the link together. No welding, burning, or riveting is needed.

Cast of "Supermang," a high manganese alloyed steel specially developed for its extra strength and ability to resist wear, it is, according to the manufacturer, as strong or stronger than other links in the chain since the parts are cast rather than welded together. **Kensington Steel, CE 6-140, 505 Kensington Ave., Chicago 28, Ill.**



Save 50% Floor Space by installing Wheeler-Economy Horizontal Pumps Vertically!

Typical vertical installation of Wheeler-Economy Single Stage, Double Suction Pump. These High-Head Pumps, usually installed horizontally, can easily be mounted vertically, with a 50% saving in floor space. Motor here is located directly over Pump, but it could have been mounted on a floor some distance above Pump.

How to save floor space is a perennial problem at municipal water works. One large midwestern municipality solved this problem recently when booster pumps were installed—with an assist from C. H. Wheeler:

Double Suction Wheeler-Economy Pumps were installed vertically instead of horizontally, thus saving half the floor space! Another advantage of this type installation is that vertical pump mounting simplifies corner installation of pumps, because in many instances the discharge elbow can be located at 90° from the inlet.

The only change in pump construction necessary to change this Wheeler-Economy horizontal installation to a vertical one, was a quick, easy modification in the placement of the thrust bearing on the pump.

If you have a pump installation involving limited space or special features, contact your Wheeler-Economy representative, or write direct to C. H. Wheeler.

C. H. Wheeler Mfg. Co.
Economy Pump Division
19th and Lehigh Avenue, Philadelphia 32, Pa.

☐ Please have a Wheeler-Economy representative contact me.
☐ Send me catalog A-155.
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Two-Way Hydraulic Loader

DESIGNED FOR THE UTMOST versatility, a diesel-powered hydraulic loading shovel, the Merton Two-Way Loader, is self-powered up to 13½-mph and can discharge its bucket at the front or over the rear. It provides straight line loading from stockpile to discharge point to afford full mobility and penetration without conventional turning and pivoting, eliminates time-wasting manuevering, reduces travel, speeds load-discharge cycles considerably and lowers wear, maintenance and operator fatigue.

The loader is unique in that discharge at both front and rear are fully controlled, and the height of the discharge can be varied from ground level to 9-ft in front and from 4-ft 10-in. to 9-ft at the rear—an extremely important feature for reducing wear and tear on vehicles being loaded.

Self-Powered

Only two pairs of double-acting hydraulic rams are used to control all bucket movements; the main lift rams incorporate an effective damping device which automatically slows down the bucket as it travels over top-dead-center, greatly reducing the stresses on the ram packings and on the machine as a whole. Double acting main rams provide positive down digging pressure—bucket movement down to 16-ft below ground level. Fingertop operated bucket hoisting, breaking and travel control are completely independent of master clutch. **Seaboard Equipment Co., Inc., CE 6-140, 7 Hanover St., New York 5, N. Y.**

Four Wheel Drive Tractor

A FOUR-WHEEL DRIVE VERSION of the 335-hp M-R-S200 Tractor is designed for hauling over pioneer type terrain, the driving front axle combining a high degree of mobility with the great traction made possible by hydraulic weight transfer.

With ample power, a static weight of 45,500-lb and large, low-pressure tires, the big tractor is capable of providing up to 38,200-lb available tractive effort.

(Continued on page 142)

(continued)

M-R-5200

An optional differential ratio is available providing a maximum available tractive effort of 44,100-lb. A semi-automatic transmission is employed, giving the tractor nine forward and two reverse speeds with maximum forward speed of 35.18-mph.

The M-R-S200 four-wheel drive tractor is recommended as a prime mover to self-load scrapers up to 20-cu yd struck capacity and for powering scrapers up to 30-cu yd struck, 39-cu yd heaped capacity when loaded with pusher assistance. Also available for use with the tractor are 30-cu yd struck capacity rear dump rock wagons and 35-cu yd struck capacity bottom dump wagons. An adjustable tilt and pitch bulldozer is available. **M-R-S Manufacturing Co., CE 6-141 and 142, Flora, Mississippi.**

Automatic Broom Re-Fiberer

THE COR-A-MATIC IS THE fastest broom winding machine on the market today according to the manufacturers, who report having observed operators strip a 5-ft core in less than one minute and filling the same core in less than 8-min. Voids and unbalance are eliminated because a solid, continuous mat of fiber travels automatically up the feed tray through the bending mechanism and then to the core. It is an easy one-man operation. The operator feeds the fiber and the Cor-a-matic does the rest automatically. **Municipal Research & Development Corp., CE 6-141, Jones Building, 1331 Third Avenue, Seattle 1, Wash.**

Vaneaxial Fans

THE FIRST MAJOR UNDER-RIVER tunnel ventilated with vaneaxial fans is scheduled for completion this fall at the mouth of the James River, Va., in the Hampton Roads area of Chesapeake Bay.

Heart of the system will be 16 fans capable of circulating 1,704,000-cu ft of air per min. Mounted vertically, they will be located on two man-made islands in the 4 mile water crossing between the Norfolk and Hampton Areas. Stringent space requirements were a factor dictating the use of vaneaxial fans rather than the centrifugal type on these islands.

The fans, engineered by Joy Mfg. Co., New Philadelphia, Ohio, are equipped with variable pitch blades for maximum versatility in regulating the volume of air to be circulated through the 7,500-ft long tunnel. Eight of the fans will be employed for intake and eight for exhaust duties.

Sixteen vertical, forced air cooled motors, developed by General Electric's Medium A-C Motor and Generator Department, Schenectady, N. Y., power the fans. The 8 supply fan motors are rated at 300/38-hp, 900/450-rpm and the exhaust fan motors are rated at 400/50-hp, 1200/600-rpm. **General Electric Co., CE 6-141, Schenectady 5, N. Y.**

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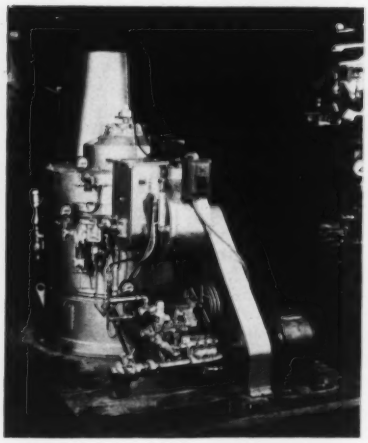
EQUIPMENT MATERIALS and METHODS

(continued)

Steam Generator

THIS OIL-FIRED STEAM generator is used by the Army's Portable Power Reactor at Fort Belvoir, near Washington, D. C. It produces steam at 600-lb pressure and 1100-lb of steam an hour to achieve 450-deg temperatures needed to make certain pre-operation tests of some of



the equipment in this new atomic power-plant.

The Vapor-Modulatic steam generator is quite similar to the automatic steam generators the company makes to produce steam for heating the nation's diesel powered passenger trains. **Vapor Heating Corp., CE 6-142, 6420 West Howard St., Chicago 31, Ill.**

Portable Batch Plant

THE PORTO-BATCHER IS a portable batch plant that disassembles into three completely roadable trailer units. Production for the new batcher varies from 60 to 100 batches per hour, depending on batch quantities and truck size. An interlocked batch control with repeater is fully automatic.

Aggregate capacity of the Porto-Batcher is 39-cu yd in four compartments, 46-cu yd possible with 12-in. staked side boards. A built-in water tank holds 650-gal with a provision made for direct connection to pressure water. Cement storage will hold 280-bbl. Two styles of discharge conveyors are available: one with an 8-ft 10-in. above ground line clearance for batch trucks; a second with an 11-ft 6-in. clearance for transit-mix trucks. **C. S. Johnson Co., CE 6-142, Champaign, Ill.**

EQUIPMENT MATERIALS and METHODS

(continued)

Heavy-Duty Fork Lift

A NEW HEAVY-DUTY FORK LIFT featuring hydraulically-operated four-way tilting and leveling is capable of lifting 15,000-lb to a full reach height of 14-ft. The machine is held suitable for most any application requiring reach, high power and maneuverability. It is produced as an attachment for the Eimco Model 105 tractor.

Hydraulically Operated

For maximum visibility and greater work control, the fork lift seats the operator at the front of the machine. Unidrive transmission with independent track reversal for spin turns, gives the fork lift versatility and operating ease even under close working conditions.

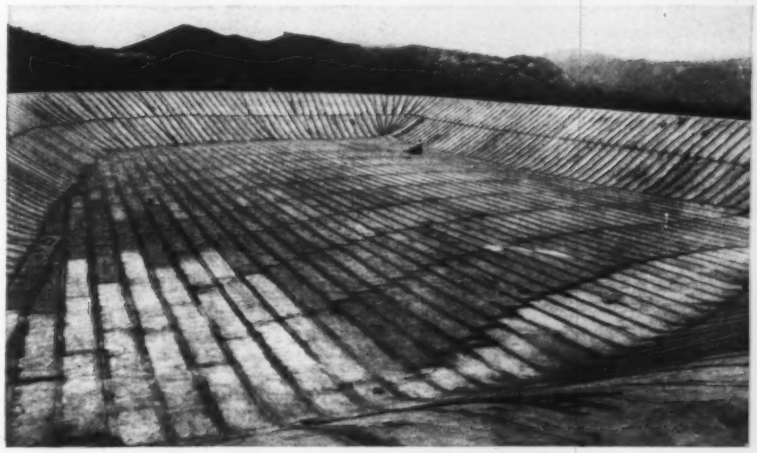
The fork lift is interchangeable with the Eimco front-end loader attachment and was designed to provide a unit flexible enough to meet materials handling jobs on uneven or sloping ground as easily as in prepared storage areas. **The Eimco Corporation, CE 6-143, 634 South 4th West, Salt Lake City 1, Utah.**

RR Aluminum Grating

A NEW ALUMINUM GRATING that meets the demands of the construction and maintenance industries for heavy and versatile usage has been announced recently by the manufacturer.

Klemp went into full scale production of this aluminum grating on January 1, 1957 and now has the facilities available to supply all demands. The RR type aluminum grating was especially designed to retain the combined advantages of a rectangular opening and riveted gratings. This grating remains structurally rigid regardless of cutouts located in any part of the panel. RR

(Continued on page 144)



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How to Make a Plumb Board for Easier Layouts

"A couple of years ago, windy days, green rodmen and terrain hazards were slowing up construction layout," recalls George Guesmer of Minneapolis. "Reference points were hidden from the transitman by brush, dirt, concrete and construction materials. With the plumb bob swinging in the wind, accurate work became impossible.

"I solved all the problems by making a plumb board. To make one yourself, obtain a builders' three-way plumb and level (used in making an ordinary mason's level) and a piece of plywood ½-inch thick, 48 inches long and the width of the plumb and level (generally three inches). Drill three one-inch holes in the plywood to permit observation of the level bubbles from the rear of the plumb board. Paint the plywood with a couple of coats of flat white.

"After the paint has dried, use black waterproof drawing ink and a ruling pen to draw a line lengthwise down the middle of both sides of the plywood. Graduate the ends of

Guesmer plumbing back of obstruction (left); offsetting.

the board in inches—or tenths, if you prefer. The alternating black rectangles make it easy to see the vertical line at a distance. To preserve the inked lines and to keep the board clean, spray the entire board with a clear plastic or brush on a clear spar varnish.

"I found my homemade 48-inch plumb board easy to handle and adequate for most work. It's especially handy for offsetting a reference line or measuring a short distance. I have run many an accurate, trouble-free mile of line using my plumb board, Gurley transits and Gurley levels."

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EQUIPMENT MATERIALS and METHODS

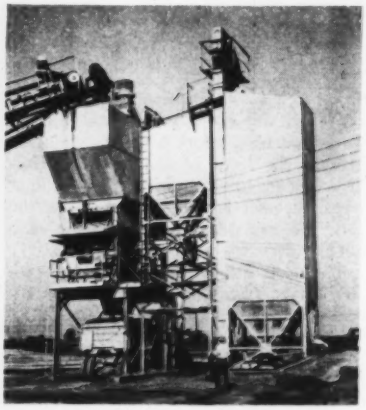
(continued)

grating is easily cleaned and offers greater durability under severe load conditions.

The Rectangular Riveted (RR) Aluminum Grating has been laboratory and field tested over a period of 5 years to meet exact load conditions. It meets the Navy Military Specifications as to design and strength and is being installed on Navy vessels. **Klemp Metal Grating Corp., CE 6-143 and 144, 6608 South Melvina Avenue, Chicago 38, Ill.**

Specially Designed Plant

A NEW CONCRETE BATCHING PLANT produces over 300-yd per hr with one operator in a 1-stop or 2-stop set-up. The plant, designed especially for the road building program, obtains its high capacity through a unique system of weighing 3 materials for a single batch at the same time—sand, coarse aggregates and cement. It batches accurately to rigid specifications and supplies 2 or 3 dual drum pavers.



Set-up as a 1-stop

In factory-assembled sections, all within legal width for highway transport, the plant can be moved to the most practical batching site and quickly erected on timbers or concrete. All batching components are permanently housed within the bin center section and require no removal on transport. The electrical connections are made by simple twistlock couplings.

A 3 pen recorder as optional equipment produces a continuous record on a single chart of the cement, aggregates and sand weights, batch designations and time of day. Cement silo has facilities for direct loading of cement spreader trucks. **The Noble Co., CE 6-144, 1860 Seventh Street, Oakland 20, Calif.**

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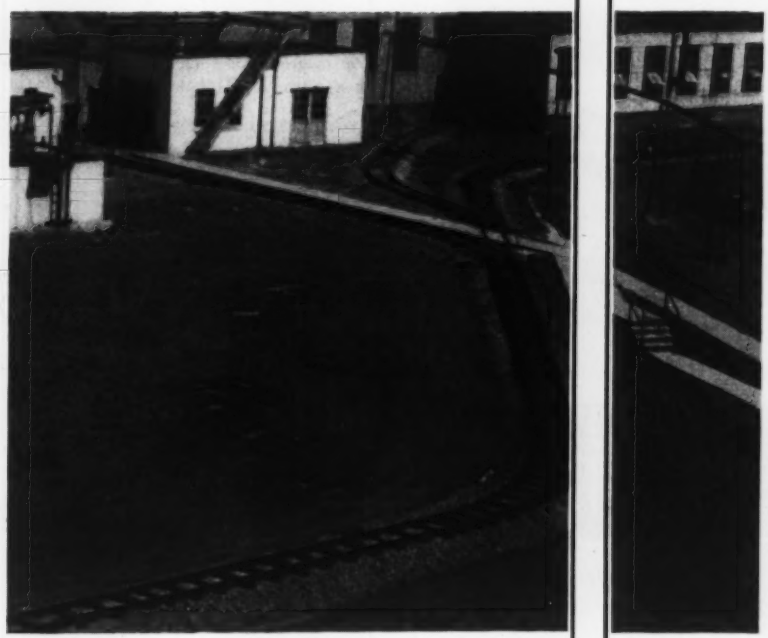

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HKP CONNORS STEEL DIVISION
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EQUIPMENT MATERIALS and METHODS

(continued)

Portable Sump Pump

A NEW, SELF-CONTAINED portable sump pump has wide application in the removal of sewage, sludge, chemicals, oil, etc. The pump body, impeller, and strainer are made of bronze, to resist corrosion and to insure spark-free operation. As a result, chemical solutions and inflammable or explosive liquids can be handled safely.

Heavy duty thrust and radial bearings support the two-part, non-clogging impeller, which is mounted on a stainless steel shaft. Bearings are double-sealed to protect them and the air motor from contamination or damage by dirt or corrosive liquids.

Requires no Priming

Requiring no priming, the pump is ready for instant use. It is 19⅝-in. high and can be passed through a hole as small as 9 by 11-in. Any liquid over 1⅜-in. deep can be picked up. Solids over ¾-in. are blocked out by the integral bronze strainer.

Pump speeds vary between 3200 and 3600-rpm, depending upon the head against which it is pumping and the supplied air pressure. Excessive speed is prevented by a built-in governor. **Schramm, Inc., CE 6-145, 900 East Virginia Avenue, West Chester, Penna.**

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Wisner Drive Overpass, New Orleans, La. G. A. Heft & Company, Engineers. Keller Const. Corp., general contractors. Built for City of New Orleans. Photo courtesy Lone Star Cement Corp.

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EQUIPMENT MATERIALS and METHODS

(continued)

Hydraulic Backhoe

THE HENRY HYDRAULIC BACKHOE Super C-10H has been approved for use with the International Harvester 130 Tractor. It is particularly suited for use with this economical tractor because of its ground-gripping feature. The backhoe sets its main frame right on the earth, putting the entire digging weight on the ground rather than on the tractor itself. The main frame is raised and lowered hydraulically.

Available with either hydraulic or manual outriggers, the Henry makes 9 feet of ground contact. The boom swings in a continuous 160-deg arc without the necessity of resetting pins. It will dig from any angle within that arc, and can easily swing a load to either side of a wide ditch.

Super C-10H

Sixteen bucket sizes are available, ranging in width from 12 to 38-in. Standard equipment on all Henry Backhoes includes full-flow oil filter, double acting chromium-plated piston rods, large pins and replaceable bushings at all pivot points, down pressure relief valve, swing cushioning valve, and a sectional spool-type control valve in a parallel circuit with free oil flow. **Henry Manufacturing Co., Inc., CE 6-146, 1700 N. Clay St., Topeka, Kansas.**

DSM Screen

THE NEW DSM SCREEN now available for the continuous wet screening of slurries containing non-fibrous solids is particularly adaptable to separations in the 8 to 48 mesh range. To date, it has been successfully applied to classifications in the metallurgical, non-metallics, chemical and food industries. Because of unique principles of design both screen capacity and efficiency are far greater than those of vibrating screens.

Basically it is a concave, horizontal-wedge-bar type of screen secured in a stationary housing. An integral part of the housing is a feed box equipped with

(Continued on page 148)

HYDRAULICS TRANSLATIONS

To avoid duplication of effort and to bring the hydraulics engineer a definitive list of available translations of literature on hydraulics, the Committee on Research of the Hydraulics Division has prepared "A List of Translations of Foreign Literature on Hydraulics." This material is available as ASCE Manual 35—the latest of a renowned series of authoritative publications on civil-engineering subjects. This Manual can be ordered by clipping this coupon and remitting as indicated below.

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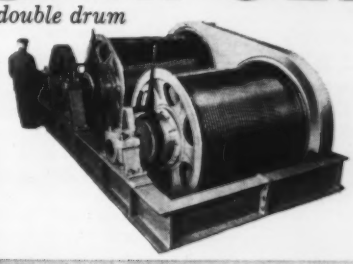

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LABYRINTH WATERSTOP after first pour has been made and form removed. The grooves receive the concrete from the second pour, providing an interlocking joint.

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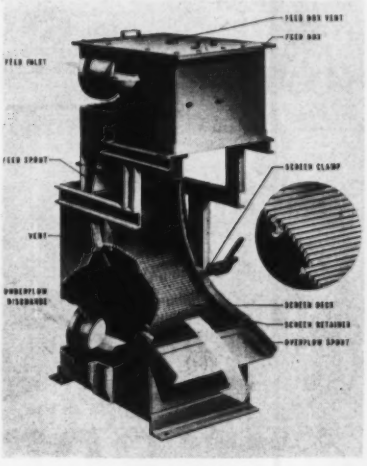
EQUIPMENT MATERIALS and METHODS

(continued)

both an inlet port and feed spout. The latter serves to distribute incoming slurry across the full width of the screen in such a manner that the feed strikes the curved surface tangentially. Undersize material which passes through the screen is collected in the lower part of the housing and is discharged through another port while oversize product flows across a lip at the base of the screen.

The Dorr-Oliver DSM Screen is available in 4 standard sizes ranging in width from 1 to 4-ft in increments of 1-ft. Vertical dimensions of all 4 sizes are identical. Capacity is approximately 200-gal per ft of width per min when making a 48 mesh separation and as high as 500-gal per ft per min in producing an 8 mesh separation. **Dorr-Oliver Inc., CE 6-146 and 148, Stamford, Conn.**



Available in 4 sizes

Swanson Ripper

A NEW TOOL HAS BEEN DESIGNED to cut the time and cost factor to a considerable degree when it is necessary or advantageous to rip outside of the width of the wheels or outside the cutting width of the blade of a motor grader. The Swanson Ripper is actually a specially designed attachment support boot which holds a standard make of ripper shank while the work is being performed.

This unit tool will effectively rip asphalt, hard pan, stratified rock, shale, adobe and concrete of reasonable thickness. It effects a great saving as compared to other methods now being used. It is also highly effective in tight places and in hard-to-get-at places, and particularly advantageous for cutting close to stakes.

(Continued on page 149)

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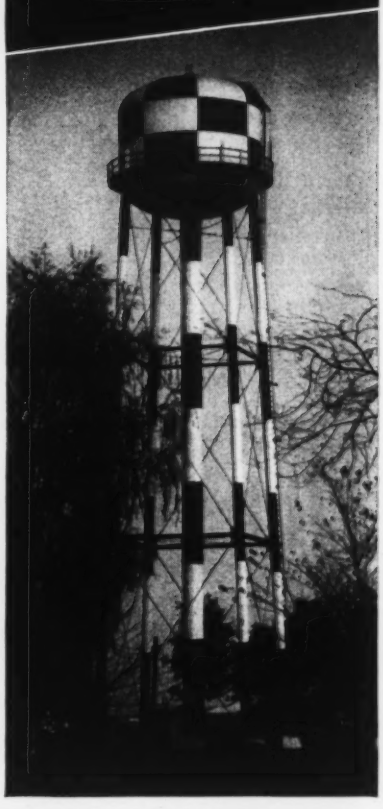
FIRE PROTECTION
AND OTHER
INDUSTRIAL
WATER NEEDS



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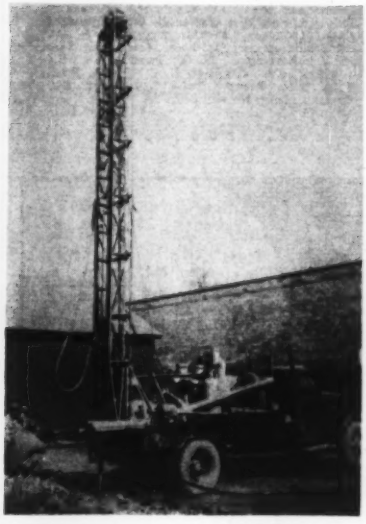
EQUIPMENT MATERIALS and METHODS

(continued)

Now being manufactured for use with the No. 12 Caterpillar Motor Grader, both Model 10 and Model 20 can be used with equal effectiveness on either the right or left hand side of the machine by merely reversing the tool which is quickly and easily attached to the motor grader moldboard frame. **Swanson Mfg. Co., CE 6-148 and 149, 515 63rd St., San Diego 14, Calif.**

Rotary Drill

AN UNUSUAL CONSTRUCTION JOB that permits a Davey M-8A rotary drill to function alternately as drill, crane and pile-driver is now being completed by Hoffman Bros. Drilling Co. in Punxsutawney, Pa.

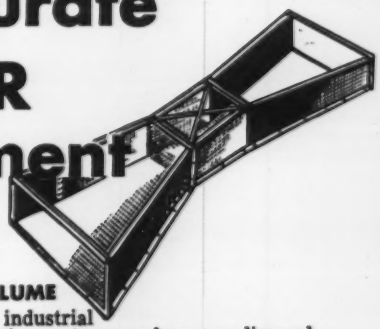


In addition to drilling 6-in. building support holes, the M-8A is used to lift piling into position and then to drive it into place. The latter operation utilizes a large circular weight welded to the upper end of 15-ft of 3-in. pipe. This is lifted by the draw-works of the drill above the center of the piling and then released. The resultant impact, when repeated, supplies sufficient force to firmly seat the piling.

The M-8A is also adaptable to water well drilling, core drilling, structure testing and shot and blast holes. The unit, which uses both compressed air and high pressure water for drilling, has a rated capacity of 6¼-in. holes up to 300-ft with air and 1,000-ft with mud. It is designed for pulling 15-ft drill section stems. **Davey Compressor Co., CE 6-149, Kent, Ohio.**

98% Accurate WATER measurement

regardless of velocity



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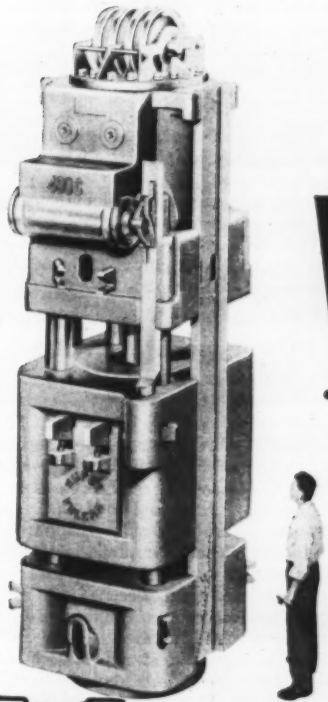

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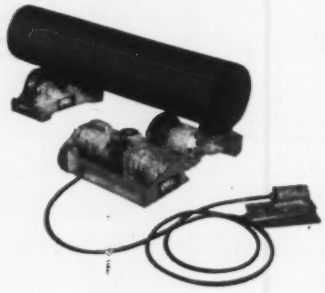
EQUIPMENT MATERIALS and METHODS

(continued)

Portable Pipe Rotators

ILLUSTRATED IS THE NEW M-15 portable pipe rotators recently introduced by the manufacturer. These units, consisting of one variable speed powered rotator and one idler rotator, are used to rotate pipe and cylinderical shapes of flame cutting and welding operations.

All wheels on both power and idler units are rubber tired. Capacity of one power and one idler unit is 1500-lb total load. More than one idler can be used where long joints of pipe are to be welded or where load capacity needs to be increased.



M-15

Wheel centers on both power and idler units are fixed, requiring no adjustment on pipe sizes from 2-in. to 24-in. Also available is a unit having adjusting spacing to accommodate work up to 8-ft in dia.

Due to the compactness of both units, they can be used as portable rotators for field use or they can be used in shops equipped with 110v a.c. **The Webb Corporation, CE 6-150, Webb City, Missouri.**

New Type Steel Joist

ADVANTAGES OF UNDERFLOOR electrification and open-web steel joists are combined in a new product. Use of the Ceco Electrical-Channel joists results in quick and economical construction and provides easy accessibility of signal, telephone and electric wiring concealed in ducts below the floor.

Heretofore, complete underfloor electrification has been restricted to relatively few buildings because of high costs. The low cost advantage of the joist lies in the fact that it is essentially a shortspan open-web steel joist with the conventional top chord replaced by a hollow duct. This serves both as a structural member and as an underfloor electrical distribution duct. Wiring can be brought up through the floor at any point along the joist where an outlet is needed. **Ceco Steel Products Corp., CE 6-150, 5601 W. 26th St., Chicago 50, Ill.**

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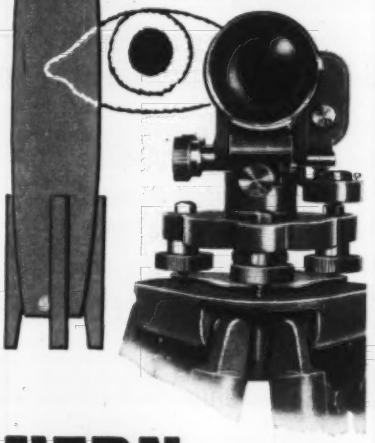

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Literature Available

FLUID CONTROL VALVES—Each page of this new bulletin SM-1 schematically shows various piping and valve arrangements for particular applications, such as supply water from source to mill; emergency fire protection; spray valves for hot strip mills; coke quenching and drain valves; preventing flywheel explosion and other mill uses. **Golden-Anderson Valve Specialty Co., CE 6-151, 1207 Ridge Ave., Pittsburgh 33, Pa.**

"SWITCHING TO SAFETY" The story of high reliability pressure switches—vital "safety centers" in the production of modern aircraft, war missiles, and industrial automation, is told in a new 20-min, 16 mm color and sound movie. The film portrays the concept, design, testing, manufacture and function of high reliability pressure switches which detect malfunction and move to correct it within thousandths of a second. **Cook Electric Co., CE 6-151, 2700 N. Southport Ave., Chicago 14, Ill.**

ALUMINUM BUS CONDUCTOR—The most complete handbook ever published on the properties and uses of aluminum bus conductor is now available. The 280-page work presents facts and figures vital to anyone responsible for engineering and maintenance of bus installations. It contains 69 graphs, tables and photographs, presenting essential information in easy-to-read, readily useable form. There is comparatively little text. Request on company letterhead. **Aluminum Company of America, CE 6-151, 793 Alcoa Building, Pittsburgh 19, Pa.**

PAVING ASPHALTS—A new 8-page, full-color booklet has been issued, describing nationwide production and distribution facilities for all types of paving asphalts and emulsions, plus various types of emulsified asphalts for construction industry. These include Bitumuls emulsified asphalts, paving asphalts, liquid asphalts and industrial asphalts, plus Laykold asphalt specialty products. Testing and research operations plus technical field services are highlighted and illustrated in the booklet. **American Bitumuls & Asphalt Co., CE 6-151, 200 Bush St., San Francisco 11, Calif.**

STEEL FABRICATING—A new 12-page two-color booklet describes and illustrates equipment fabricated recently, broken down into fabrications for steel mills, such as buckets, water cooled doors and frames, hooks, etc.; for chemical and petroleum processing plants, heat exchangers, columns, jacketed stainless steel tanks and kettles, etc. Several pages are devoted to a description of the two McGregor-Michigan plants, facilities, steel plate warehousing and specialized services. **Robert C. Hilprecht, Sales Manager, McGregor-Michigan Corp., CE 6-151, 5817 Rivard St., Detroit 11, Mich.**

IDEAS *for highway and airport paving*

NEW 36-page educational text-book catalog, illustrated by 85 photographs, diagrams and charts, covers all phases of concrete paving plant operation for the benefit of highway and airport contractors and engineers. It features:

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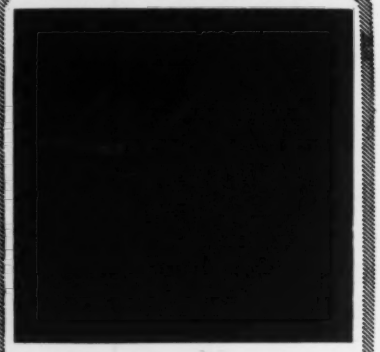

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FREE Bulletin No. 18 shows car details; No. 21 illustrates Automatic Coupler.

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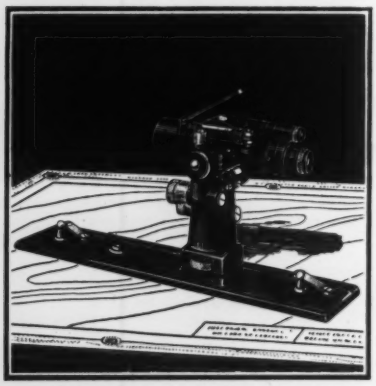

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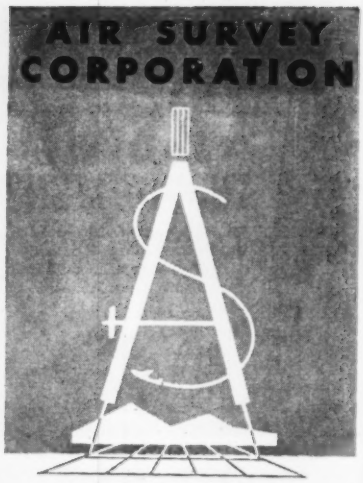
Literature Available

PANEL METHOD—A new manual on Armco Steel Building features the Steelox panel method of construction. More than 5,000 building sizes meet every space need. Some of the buildings described and illustrated are S-2 frameless, S-3 rigid frame, shed roof, and utility. Accessories and special features are covered in some detail. Among listed advantages are simplified panel construction, neat appearance, little or no maintenance, and ease of expansion, rearrangement or relocation. Write for Manual SX-14456. **Product Information Service, Armco Drainage & Metal Products, Inc., CE 6-152, Middletown, Ohio.**

IH TD-24 MAILER—An 8-page, two-color pamphlet, "Boss Of The Big Jobs," emphasizes the solid framework of the 200-hp TD-24, its planet power steering, and the option of torque converter or gear drives. Line drawings illustrate components of the torque converter drive system, the main frame, and a cutaway exposure and explanation of the planet power steering system. Diagrams indicate steering clutch positions when operator desires unit to make gradual, feathered or pivot turns. **Folder CR-565-G, International Harvester Co., CE 6-152, Construction Equipment Div., 180 N. Michigan Ave., Chicago 1, Ill.**

SEALING JOINTS—The Joint Sealer Manufacturers Association, through the cooperative effort of the member companies, have published a brochure "Joint Sealing Manual," which pertains to the sealing of joints and cracks in concrete and bituminous pavements. This technical booklet provides the engineer, architect, contractor, engineering student and others with authoritative up-to-date information concerning the materials, equipment and methods used in sealing joints and cracks in concrete pavements. **Servicised Products Corp., CE 6-152, 6051 West 65th St., Chicago 38, Ill.**

EARTH DRILLING ACCESSORIES—A handy catalog-packet has combined descriptive literature for the convenience of contractors, aggregate prospectors, state and government highway departments and others in the soils engineering and soils testing fields. The main body of the catalog is devoted to Mobile's extensive line of earth drilling accessories including augers, core barrels, drilling heads and bits, winches, couplings and other equipment. Pockets on the inside front and back covers carry additional literature on the company's complete line of mobile rotary drilling rigs, as well as the story of Mobile's soil and foundation engineering service. **Mobile Drilling, Inc., CE 6-152, Dept. 19, 960 N. Pennsylvania St., Indianapolis 4, Indiana.**



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Films Available

"KEY TO THE EMERALD EMPIRE"—A new 28-min color and sound motion picture telling the story of the construction of Lookout Point Dam on the Middle Fork Willamette River, is now available for showing to schools, clubs and civic groups. A 16 mm film the picture traces the building of this key unit in the Corps of Engineers' Willamette River Basin multiple purpose project and Lookout Point's reregulating unit, Dexter Dam, three miles downstream. Also available for showing are other 28-min color and sound films on the Dalles Dam, Detroit Dam, Mud Mountain Dam and Albeni Falls Dam. **Technical Liaison Branch, North Pacific Div., Corps of Engineers, CE 6-153, 210 Custom House, Portland 9, Oregon.**

"MODERN METHODS FOR JOINING METALS"—This new film shows a variety of welding processes and applications, and is treated in a generally non-technical manner, which makes it both interesting and informative. Filmed at leading metal fabricating companies, and Linde's laboratories, the 20-min sound and color motion picture illustrates the importance of the welding engineer in industry. It also shows the many factors involved in electric welding, and how research, development and engineering serve to provide increasingly better methods and equipment. **Linde Air Products Co., Div. of Union Carbide and Carbon Corp., CE 6-153, 30 East 42nd St., New York 17, N. Y.**

"LIFELINES FOR CIVILIZATION"—A brand new documentary film which was over a year in the making, had its premier showing at the AWWA. Specially produced for the American Concrete Pressure Pipe Assoc., the film dramatizes the development of water supply systems down through the ages. Professional actors and authentic sets were created for the historical scenes. 16 mm prints of the film that has a running time of 20-min are available on loan for group showing. **American Concrete Pressure Pipe Assoc., CE 6-153, 228 N. LaSalle St., Chicago 1, Ill.**

"ON THE MOVE"—Release of a new color-sound 28-min, 16 mm film which deals with the subject of transportation; points out the important role played by shovels, cranes and other road building equipment in this important phase of civilization progress has just been announced. Covered in the film is the gigantic St. Lawrence Seaway project, material handling and general turnpike construction. The human interest plot projects the story of a student engineer who is confronted with a decision as to the field he will enter. **Baldwin-Lima-Hamilton Corp., Advertising Dept., CE 6-153, Lima, Ohio.**

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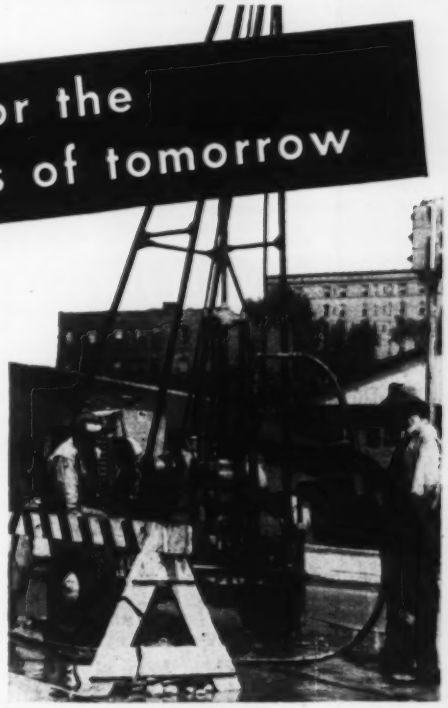

When it's better to be safe than sorry, engineers investigate underground conditions. And, that's exactly what this Acker TH drill is doing — drilling test holes over a walled-up section of the old Erie Canal preparatory to building an overhead express highway.

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From the MANUFACTURERS

WOODEN LEAD PENCIL CAMPAIGN: The Eagle Pencil Co., New York City, for 101 years a manufacturer of quality lead pencils, is mailing a complete merchandising kit which features the slogan "Eagle is on the move" and touches on all aspects of its half million dollar campaign for 1957. The kit is intended to emphasize the unprecedented advertising support which Eagle is giving its dealers . . . **COMPLETES LINE WITH BUDA PURCHASE:** Mobile Drilling Inc., Indianapolis drilling equipment manufacturer has purchased the Buda Earth Drill Division of Allis-Chalmers Mfg. Co. With the addition of this line Mobile now ranks among the world's largest manufacturers of such equipment . . . **PLANT ADDITION:** An $8,500,000 addition to the Lincoln Company's Cleveland, Ohio, plant was commenced in April. Built by the Austin Co., the new building will cover almost 30 acres . . . **STREAMLINED WAREHOUSE:** Built for Falls Products, Inc., Genoa, Ill., by the Normandy Const. Service Inc. with the cooperation of Reynolds Metals Co. engineers, a new streamlined warehouse has a nested-type roof incorporating 40-ft clear spans allowing for lateral expansion. Of rigid frame construction, 6-in. Dow Penta treated poles were used covered with 2½-in. corrugated embossed Reynolds aluminum sheet . . . **ANNIVERSARIES:** Graver Tank and Mfg. Co., Inc. is celebrating its 100th anniversary. Starting with the two Graver brothers, the firm now employs over 4,000 people. Layne & Bowler, Inc., Memphis, Tenn., are also celebrating their 75th year and new officers have been named. William H. Reeves becomes president and James I. Seay who has served as president for the past twelve years has been named chairman of the board . . . **OFFICERS ELECTED:** At a recent meeting of the Board of Directors of Infilco, Inc., P. N. Engel was elected chairman of the board and J. S. Gustafson was elected president. For fifty-five years, Mr. Engel has been active president of Infilco, founded by his father in 1896. The company has grown since then from a household faucet filter manufacturer to one of the largest designers and producers of high-rate liquid treating equipment in the world. Mr. Gustafson joined the company in 1951 and has been vice president since 1953 . . . **APPOINTMENTS:** John V. S. Norton has been appointed assistant sales manager of Bucyrus-Erie Company, South Milwaukee, Wis. Mr. Norton has been employed in the company's New York office since 1945 . . . Joseph J. Wass has assumed the position of Assistant to Manager of Manufacturing for the Heltzel Steel Form & Iron Co., Warren, Ohio.

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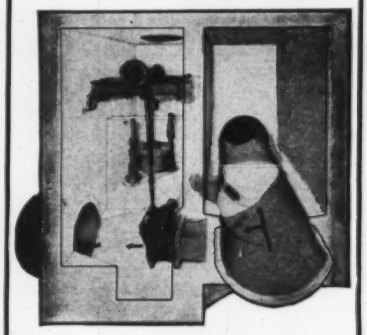

Fig. B-19

Automatic Sewage Regulators control sewage flows either by partially or completely cutting off such flows to suit head or tail water conditions or by "governing" to discharge a predetermined quantity regardless of head or tail water conditions.

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April

1222. Sanitary Engineering Education: Air Pollution Engineering, by Harvey F. Ludwig and Frank A. Butrica. (SA) The increased importance of air pollution in modern technology is creating problems which must be solved. At the present time the sanitary engineering education falls short of preparing the engineers for solving air pollution problems. A new curriculum for specialists in air pollution is outlined.

1223. Sanitary Engineering Education: Industrial Wastes Engineering, by Ross E. McKinney. (SA) The current sanitary engineering education, with its undergraduate civil engineering and graduate sanitary engineering, fails to train engineers to solve industrial waste problems. The best background lies in chemical engineering or in the new biochemical engineering.

1224. Sanitary Engineering Education: ICA Assistance in Peru, by Marvin L. Granstrom. (SA) The United States, through the University of North Carolina School of Public Health and under the assistance of the International Cooperation Administration, has undertaken the task of assisting the Universidad Nacional de Ingenieria, Lima, Peru, in developing an adequate sanitary engineering program.

1225. Discussions of Proceedings Papers 959, 1089. (PO) Andre Coyne closure to 959. Robert C. Price and T. G. Swennes on 1086.

1226. Discussions of Proceedings Paper 867. (WW) E. D. Butcher, Bailey T. Bardeleben on 867. Willard P. McCrone closure to 867.

1227. Discussions of Proceedings Papers 885, 928, 1002, 1078, 1083, 1115, 1172. (SA) V. B. Lamoureux closure to 885. Corrections to 928. Gerald T. Orlob and Robert G. Butler closure to 1002. Ralph Porges on 1078. Claes N. H. Fischerstrom on 1083. Thomas R. Camp on 1115. Corrections to 1172.

1228. Discussions of Proceedings Papers 934, 940, 1079, 1080, 1081, 1145, 1160. (SM) Charles R. Foster and W. J. Turnbull closure to 934. James F. McNulty closure to 940. Yoshichika Nishida, S. F. Gisienski on 1079. John A. Focht, Jr. on 1080. Ralph F. Reuss; R. B. Peck, M. T. Davisson, and Vello Hansen; Raymond Lundgren; Lymon C. Reese; E. A. Ripperger; Hudson Matlock on 1228. A. Warren Simonds on 1145. T. H. Wu on 1160.

1229. Discussions of Proceedings Papers 945, 1032. (EM) H. A. Einstein and Huon Li closure to 945. Corrections to 1032. William Zuk closure to 1032.

1230. Discussions of Proceedings Papers 668, 953, 1006, 1038, 1077, 1082, 1114, 1157. (HY) Norman H. Brooks closure to 668. Enos J. Carlson and Carl R. Miller closure to 953. L. J. Tison on 1006. Francis F. Escoffier closure to 1006. M. B. McPherson and R. G. Dittig; F. Paderi on 1038. Ven Te Chow on 1077. Mikhail S. Hanna; M. Gamal Mostafa; Y. M. Simaika and N. Boulos on 1082. Ven Te Chow on 1114. Corrections to 1157.

May

1231. Column Design Simplified, by Richard H. J. Pian. (ST) A simple general approach to the analysis of columns within elastic range is developed. The application to practical design problems is simplified by introducing a four-quadrant graph, which may be used for column design having different degrees of imperfections, different end connections, and materials with different yielding stresses.

1232. Inelastic Behavior of Impulsively Loaded Beams, by M. J. Greaves and F. T. Mavis. (ST) This paper presents useful methods of solving design problems involving the motion of a beam where (*a*) the applied load is impulsive and (*b*) the distortions are inelastic. A nondimensional characteristic number is proposed to order and classify many forms of impact and impulsive loads on a single basis.

1233. Analysis of Multi-Story Building Frames, by T. F. Hickerson. (ST) The analysis of a multistory building frame is presented based on the slope-deflection theorem. Applying statical equilibrium at each joint and in every story of the frame gives as many equations as unknowns, but solving these equations is prohibitive. Hence, approximate methods converging rapidly toward accuracy are desirable.

1234. Beam Deflection in Bridges Designed for Continuity, by Guillermo Villena. (ST) This paper presents a formula for deflection at any point for continuous beam bridges where the beams are of constant moment of inertia and constant modulus of elasticity. The formula applies also to variable moment of inertia and to any number of continuous spans.

1235. The Relationship of Irrigation to Public Health, by Lloyd E. Myers, Jr. (IR) Serious, mosquito-caused public health problems exist in many irrigated areas of the United States. They are primarily the result of faulty irrigation structures and practices which also cause water waste, damaged soils, and reduced crop production.

1236. Pumping Requirements for Leveed Agriculture Areas, by H. W. Adams. (IR) A method is presented for determining the optimum pumping capacity requirements for stations serving leveed agriculture areas. This method takes into consideration the basic hydrologic and economic factors. An economic evaluation is presented, based on the unit costs of pumping to reduce the depth and extent of flooding and to reduce the duration of flooding.

1237. Characteristics of New Type Cargo Ships, by Douglas C. MacMillan. (WW) This paper examines the design characteristics and functional problems of the roll-on, roll-off type of ship and of certain lift-on, lift-off types having similar basic features.

1238. Hurricane Design Wave Practices, by Charles L. Bretschneider. (WW) Methods are presented for allowing a better estimate to be made of obtaining hurricane design waves for offshore and coastal structures. Two important concepts are described, which allow the hurricane design wave and its recurrence interval to be obtained reliably: The "Energy Index" to obtain the design hurricane for deep-water wave conditions, and techniques for computing wind waves over a shallow bottom taking bottom friction into account.

1239. Modern Facilities for Ohio River Navigation, by James W. Bruce, Dwight W. Keller, and James A. Neill. (WW) Because of physical deterioration, obsolescence, and increasing traffic, it is necessary to modernize and

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replace navigation facilities on the Ohio River and certain major tributaries. This paper presents the general requirements and criteria establishing the characteristics of replacement facilities now being constructed or in the planning stage.

1240. Mississippi River-Gulf Outlet, by William H. Lewis and L. C. Brune. (WW) A resume is given of the history and background of a project of vital importance to the City of New Orleans (La.) and the Mississippi Valley—the construction of the Mississippi River-Gulf Outlet. The development and costs of the project are examined, together with the technical and engineering features. However, the content of the paper is essentially nontechnical, due to the present state of the planning.

1241. Mobile Harbor and Ship Channel, by Harold E. Bisbort. (WW) The Port of Mobile (Ala.) is located at the head of Mobile Bay, an arm of the Gulf of Mexico having natural depths inadequate for deep-draft vessels. This paper describes the gradual improvement of the channel through the years and traces the history of its effect on commercial and industrial activity.

1242. Mississippi River—Baton Rouge to the Gulf of Mexico, by Otis M. Jernigan. (WW) The navigation project for deep-draft shipping on the lower Mississippi River extends 250 miles upstream from the Gulf of Mexico. The effect of the major features of the project on commerce and industry are described and related to the proposed New Orleans (La.) tidewater channel and other waterway improvements.

1243. Flood Control for the Mississippi-Yazoo Delta, by C. K. Little. (WW) The Mississippi-Yazoo Delta is protected from flooding by the Mississippi River by levees along the east bank. However, large areas are subject to flooding from interior drainage, runoff, and backwater from the river. The Corps of Engineers (United States Department of the Army) is constructing flood-control works for the area.

1244. The Constructor's Problems, by Charles E. McKee. (HW) This paper reviews the roles of the highway administrator, the engineer, and the contractor in an expanded highway program. Problems of management are discussed, as well as the manner in which many of these problems can be minimized.

1245. Problems of Engineering Management, by Edward J. Donnelly. (HW) Engineering management comprises the direction, supervision, and coordination of the design and construction phases of a highway program and will be a major factor in the successful completion of the national highway program.

1246. Operating Problems of Maintaining Uninterrupted Use, by H. George Yeager. (HW) The "Interstate System" of limited access highways will provide motorists with the most modern routes that can be devised. Unless maintenance and maintenance procedures are revised and amplified to provide uninterrupted use, freedom of movement and carrying capacity provided by construction will be greatly restricted.

1247. Legal Problems Relating to Construction of Expressways, by Joseph D. Buscher. (HW) This paper presents the more important legal problems faced by highway departments and engineers in constructing expressways. Treated at some length are right-of-way acquisition and condemnation for future construction, "prior entry for construction purposes," and the right to exclude abutting property owners from access.

1248. Shoreside Facilities for Special Purpose Ships, by Howard J. Marsden. (WW) A brief history is given together with the current situation regarding special purpose vessel operations and proposed ship construction program, as well as the layout, general design criteria, and technical analyses of roll-on, roll-off, lift-on, lift-off containers and conveyor terminals for trailerships, trainships, and containerships.

1249. Operation Problems on Controlled Access, by Charles M. Noble. (HW) The paper emphasizes the advantages of the controlled access highway and outlines the facilities necessary to provide for the comfort and safety of the public.

1250. The Use of Technicians in Highway Engineering, by Scott H. Lathrop and Francis J. Farias. (HW) The importance of making the best possible use of nonengineers and engineering technicians is stressed as being the only solution to the problem of the continuing shortage of engineering graduates.

1251. Evolution of the Mississippi Valley Flood Control Plan, by John R. Hardin. (WW) The development of the lower Mississippi Valley flood control plan is traced from its beginning to the comprehensive plan now being conducted by the Corps of Engineers (United States Department of the Army).

1252. Navigable Waterways and Industrial Development, by Dewitt L. Pyburn. (WW) Effects of navigable waterways on industrial development in the South are described together with the effects of the availability of water and flood protection. Parallel developments of navigable waterways and industrial concentrations are traced for the Mississippi River and Warrior-Tombigbee River and for the Gulf Intracoastal Waterway.

1253. Irrigation-Drainage-Climatology for Flat Humid Land, by Harry Rubey. (IR) Irrigation, drainage, and climatology are combined under professional corporate management for an engineer-agronomist-climatologist type to increase profits greatly on large holdings of flat humid lands.

1254. The Behavior of One-Story Reinforced Concrete Shear Walls, by Jack R. Benjamin and Harry A. Williams. (ST) Results are given of an investigation of one-story plain and reinforced concrete shear walls subject to shear forces applied in the plane of the wall. Panel proportions and reinforcing and column proportions and reinforcing were investigated. Some approximate relationships are suggested for predicting the load-deflection curves for these walls.

1255. Lateral Load Distribution Test on I-Beam Bridge, by Ardis White and William B. Purnell. (ST) This paper presents procedures, results, and conclusions from a strain gage test performed on a highway bridge to determine (1) the degree of composite action and (2) effectiveness of the diaphragms in lateral distribution of loads.

1256. Manpower Problems in the Highway Program, by C. E. Fritts. (HW) A program of action is necessary to bring more students into the civil engineering field to help the better placement of men and to place salaries on a competitive basis. Positive action must also be taken on incentives such as stability of employment and advancement, retirement benefits, working conditions, health and welfare, and professional recognition.

1257. Discussions of Proceedings Papers 884, 961, 1103, 1104, 1105. (IR) R. D. Goodrich closure to 884. N. B. Bennett, Jr. closure to 961. C. L. McGuiness, J. G. Ferris, Meyer Kramsky on 1103. Carl Rohwer, Kenneth M. Turner, Irvin M. Ingerson on 1104. M. A. Selim on 1105.

1258. Discussions of Proceedings Paper 1090. (HW) A. H. Brownfield, J. J. Naughton, Angel Piccio Villasor, Jr. on 1090.

1259. Discussions of Proceedings Papers 851, 973, 1019, 1020, 1022, 1096, 1097, 1101, 1106, 1108. (ST) Corrections to closure to 851. Corrections to 973. Roy C. Edgerton and Gordon W. Beecroft closure to 973. Milton Brumer and C. W. Hanson closure to 1019. M. W. Huggins and W. L. Lin closure to 1020. Phil M. Ferguson closure to 1022. Arturo J. Bignoli on 1096. Harold G. Lorsch on 1097. A. F. Foerster on 1101. I-Chen Chang on 1106. Corrections to 1108.

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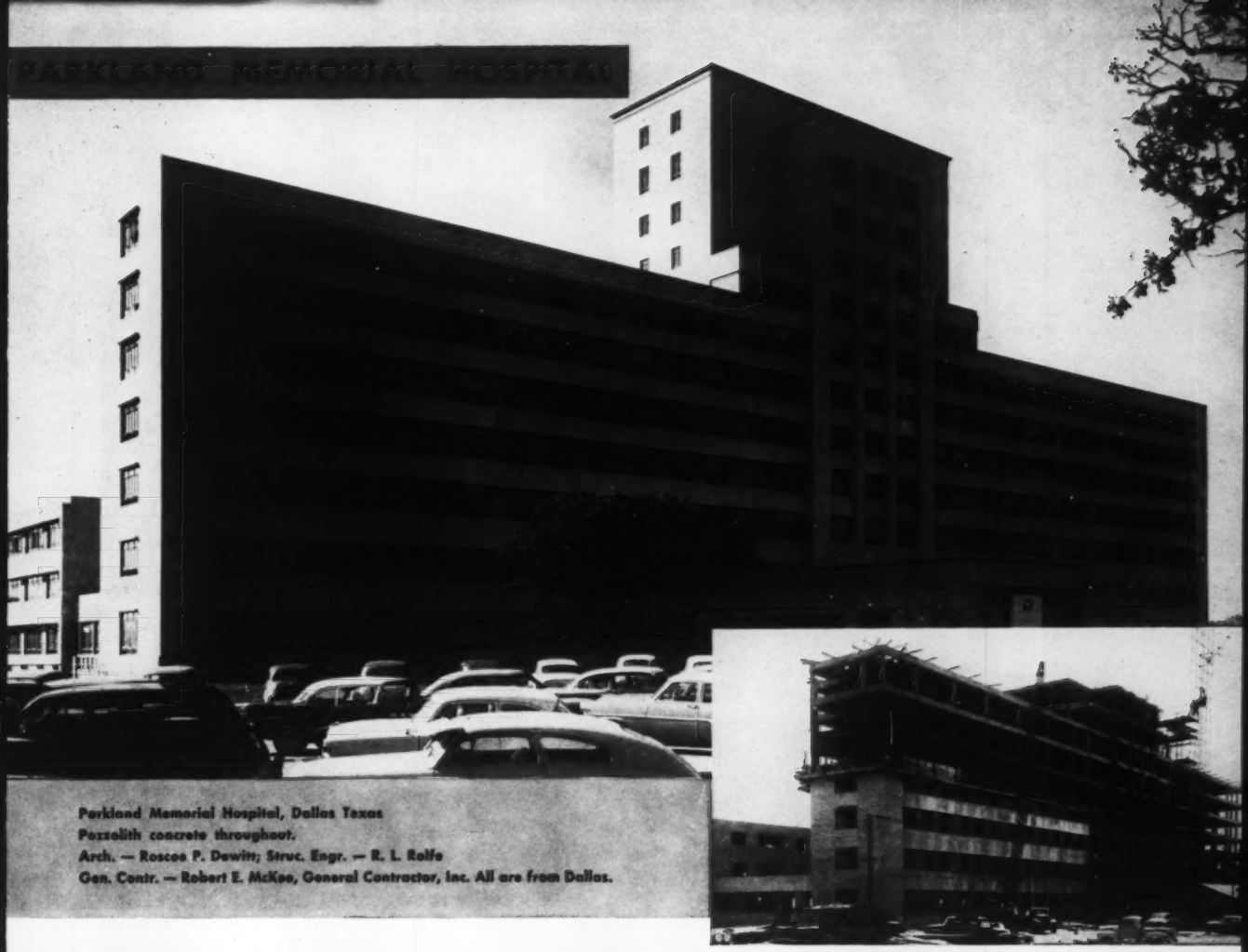

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